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OUR COVER

This month's cover picture shows a technician making adjustments to the timing unit of the latest Marconi "suitcase" TV transmitter. This transmitter is contained completely in several small units, like the one illustrated, each no larger than an ordinary suitcase.

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F.M. or A.M.?

Every now and again there appears on the technical horizon a new and seemingly revolutionary development which looks as if it should provide the answer to a problem of long standing, hitherto unsolved. Such a development was that of frequency modulation, first demonstrated by Armstrong in 1936, and described by him in what has now become the classical paper on the subject. Since then, considerable progress has been made in the technique of F.M., and it has been used on a relatively large scale for a number of purposes. It has been very widely publicized, and has been surrounded by more controversy than perhaps any other development that has made its appearance in the last twenty-five years. Indeed, the arguments are still going on, so that there is legitimate ground for asking, first of all, what the fuss is all about, and secondly, why we in New Zealand have not yet become embroiled in it to any significant extent.

The history of F.M. is a very interesting one. Armstrong's demonstration of wide-band F.M. in 1936 was by no means the first that had been seen of frequency modulation. In 1920 a number of prominent engineers in the United States (Armstrong himself among them) propounded the idea that by frequency-modulating a carrier to the extent of say, $\pm$ 100 cycles per second, and by using a receiver with a pass-band only 200 cycles wide, communication could be carried out in a way that would be much less subject to interference than ordinary A.M. had already been found to be. This argument was entirely fallacious, as another famous American, Carson, shortly pointed out in a now equally famous paper on the theory of modulation. Carson showed that even when the frequency deviation was limited to a low figure like 100 c/sec., the resulting modulated signal occupied a band that was, if anything, rather wider than that of a conventional A.M. transmission, and also, that if an extremely selective receiver were used to receive the so-called narrow-band F.M. signal, the greater proportion of the sidebands, carrying the intelligence, would be rejected, with the consequent loss of the said intelligence.

In spite of this, Armstrong proceeded with his experimental work on the assumption that "static" possessed the characteristics of an A.M. signal, so that any signal that differed fundamentally from an A.M. one should have a good chance of being less susceptible to interference. Armstrong's equipment had the most sweeping claims made for it, particularly in respect of its ability to discriminate against "static," whether natural or man-made, and caused a first-rate to-do in technical circles. Unfortunately, however, certain of its characteristics were not as favourable as they might have been, and in consequence received somewhat less publicity than impartiality would have made desirable. At the same time, business interests connected with the vast commercial broadcasting set-up in the U.S.A. saw in the new development a heaven-sent opportunity for opening up new channels, and of reaping richer harvests for themselves in the process. So it was that F.M., from being something of a technical curiosity, rapidly rose to the status of a carrot, dangled before the eyes of those much-cultivated donkeys, the commercial sponsors.

All this had the unfortunate effect of completely clouding the issue of whether the new form of modulation really had anything to offer against its well-entrenched competitor, A.M. Those who embraced F.M. as a development worth watching, to see if anything would come of it, published highly coloured evaluations of its usefulness, practically all of which failed completely to take into account a number of fundamental differences between it and its rival. The freedom from interference of F.M., used at some very high frequency, where natural static did not occur anyway, was gleefully compared with the susceptibility of A.M. on the broadcast band. Likewise, the fidelity of F.M. transmissions, in which the upper modulation frequency limit was 15,000 c/sec. was hailed as vastly superior to that of ordinary broadcasting, where channel-width restrictions limited the highest transmitted frequency to 5000 c/sec. Per contra, everyone completely failed to mention the fact that amplitude modulation, used at the same carrier frequency, and with the same audio bandwidth, might possibly give as good fidelity as the F.M. transmissions.

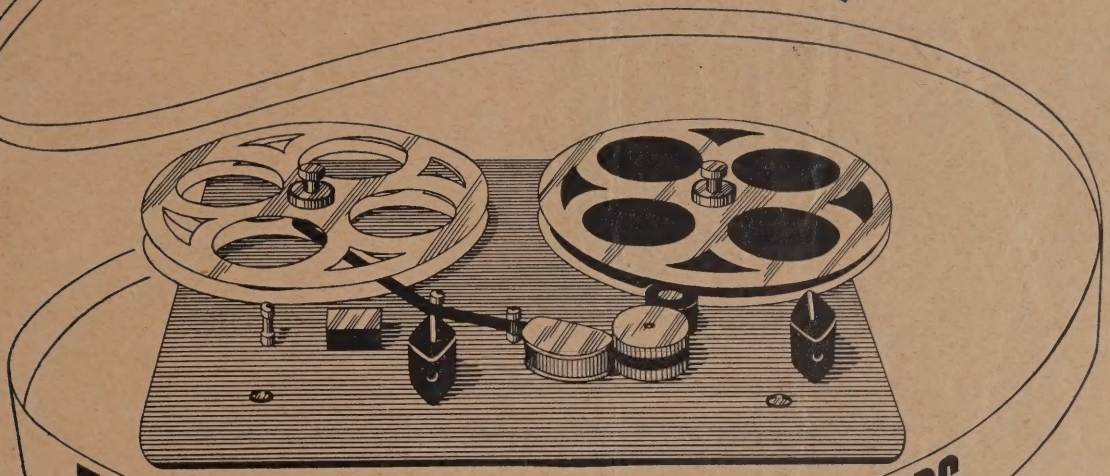
The A.M.-F.M. controversy was extremely good fun for engineers who had nothing at stake either way, and provided another point for argument whenever a new radio service was to be inaugurated. Should it use F.M. or A.M.?

At length F.M. broadcasting obtained quite a following in the United States, where the conditions were favourable to its forced development, and it was written into the post-war specification for the American television standards. At present, as far as is possible to tell by reading American publications, TV has so far stolen the limelight that F.M. broadcasting appears to be dying a natural death, while A.M. broadcasting is as lively as ever, if not more so.

At the same time, F.M. seems to have more than held its own in the post-war development of mobile communications equipment, and similar fields. In America, that is, for in Britain, and in New Zealand, too, there is a preponderance of A.M. equipment of this kind. Here again the facts seem to indicate that perhaps F.M. does not have in practice all the advantages that its protagonists would claim for it.

One of the few properly conducted comparative tests that have been made was undertaken recently by the B.B.C., who felt that in order to make a proper choice between the two systems for their projected V.H.F. broadcasting, tests should be made on the same radio frequency with the same peak power output. Here the answer has been that F.M., given a receiver that is in proper adjustment, gives slightly superior results towards the fringe of the coverage area and in situations where impulsive interference is bad. This points to the real difficulty—namely that unless the F.M. receiver is properly tuned, and has its circuits exactly aligned, the difference in performance is small, if it even exists. Add to this the fact that an F.M. receiver is necessarily more expensive than its A.M. counterpart, and it becomes apparent that from the public's point of view, any service which requires them to have an F.M. receiver must be a mixed blessing, to say the least. As for mobile services and the like, there seems no doubt that the more severe conditions under which their receivers operate must certainly nullify any rather tenuous advantages that may be claimed for them. It is to be hoped that the authorities will give very serious consideration to this point when they are deciding which system of modulation should be used in the sound portion of te television which we hope to have in the not-too-distant future.

Qualitape



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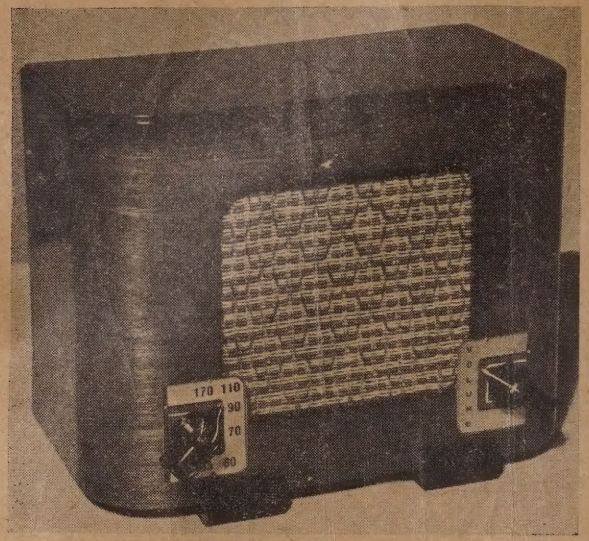
A Small Four-Valve Broadcast Receiver

This little set has been designed, partly in order to show how a set can be built into a small space without undue cramping of parts, and partly for those readers who feel the need for as compact a set as possible, but one with good broadcast band performance.



INTRODUCTION

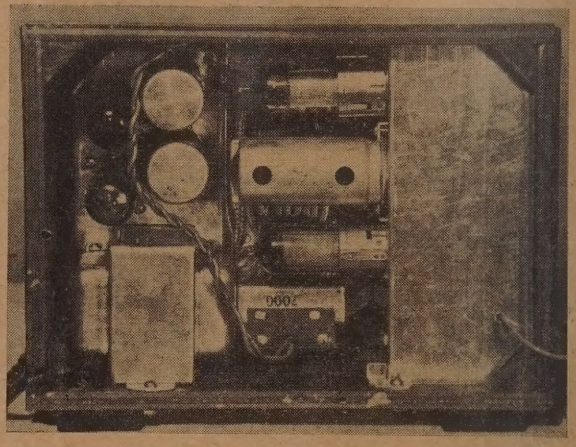
Although the set described in this article is not really a miniature, it is smaller than most commercial receivers on the market today, having been built to fit into a cabinet designed for a 5 in. extension speaker! At the same time, it has not been so jammed together that it is a major feat to get some of the parts in, nor has performance been sacrificed to compactness. Four "Rimlock" valves have been used, comprising ECH42 oscillator-mixer, EAF41 I.F. amplifier and second detector, EL42 output and EZ41 rectifier. The R.F. end is exactly comparable to that of the more usual five-valve line-up, while the only departure from conventionality is the omission of an audio amplifier stage between the detector diode and the output stage. However, since the EL42 is a high-slope pentode, requiring only a very small signal voltage to drive it fully, this omission is hardly to be noticed in so far as the set's performance is concerned. The sensitivity is comparable to that of any five-valve set, so that the small physical size of the receiver need not lead to the wrong conclusion that it is good for local station reception only. Far from it. Those who want a small set for their bedside tables, yet one which will bring in their usual stations as well as the "big" set, could do a great deal worse than try this possibly unique arrangement.

GENERAL DESIGN

One of the chief difficulties confronting amateur set-builders is that of finding suitable cabinets to house their "works" once these are completed and working. Being, like others, it is suspected, a little lazy in this respect, we first of all cast about for a suitable small cabinet that could be bought anywhere, and finally a small extension-speaker cabinet was decided upon as almost ideal. It really was small, and yet housed a 5 in. speaker, with plenty of room inside for the installation of the innards. Plenty of room, that is, if one were prepared to throw overboard some pre-conceived ideas of what a radio chassis ought to look like!

In the first place, it took only a very brief inspection to bring home the fact that any attempt to put the set on one chassis would result in some very tight squeezes indeed. But why use only one chassis? There is no law against using two, or even three if necessary! And splitting the set up into two looked as if it would enable much more efficient use to be made of the space that was available. Accordingly, it was decided to build the circuit in two parts. The first, which would contain everything up to and including the detector diode, would stand upright, on one end, at one side of the cabinet, while the remainder, comprising only the power supply and the output valve, would easily be accommodated on the other side. The unit containing the set proper turned out to be reasonably large, and, as can be seen from the photographs, uncramped. At one end (the bottom, when in position) is the midget two-gang condenser, which is accommodated entirely below the chassis, which is of conventional U-shaped constructed, and made from thin aluminium sheet.

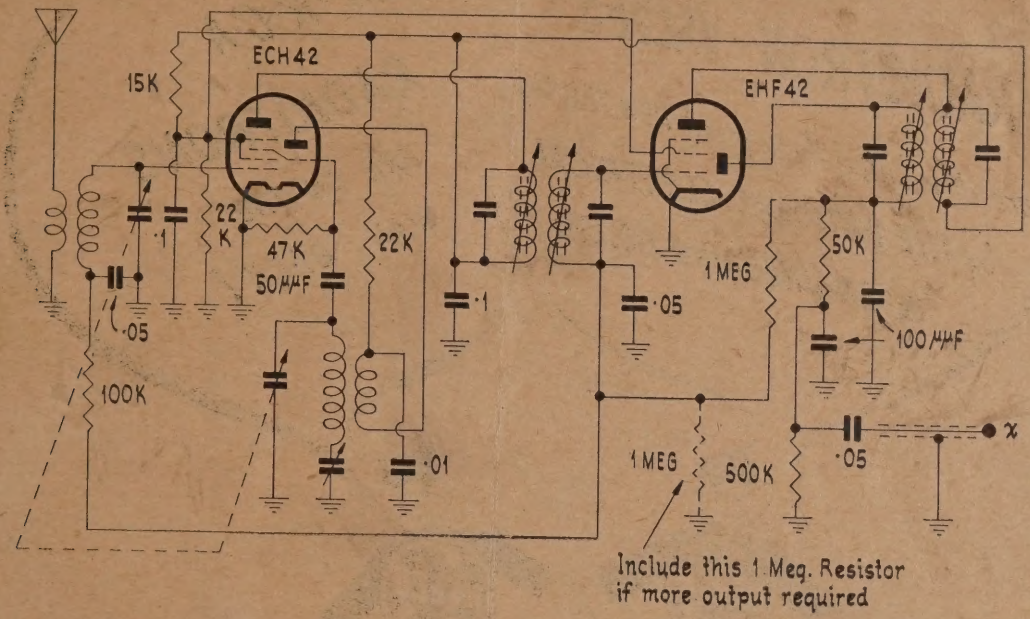
When it came to the second unit, however, the best form of construction was not at all obvious, since even the smallest commercially available power transformer



Back view of the set showing how the two small chassis fit in on each side of the speaker. The left-hand one houses only the power supply and the output stage.

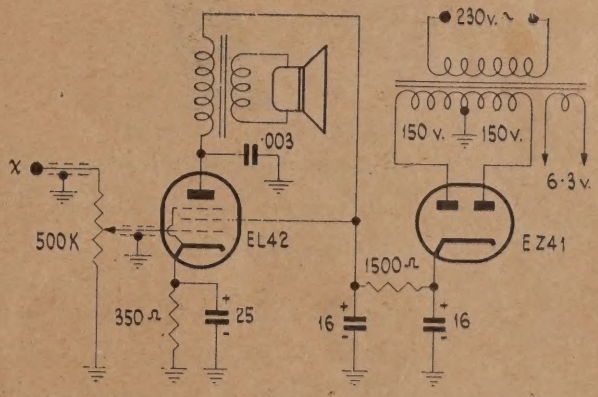
was quite bulky, and because besides the transformer, there had to be room for two valves and two electrolytic condensers. After much cogitation, discretion was thrown to the winds, and instead of mounting the transformer on the chassis, the chassis was mounted on the transformer! This "chassis," so called, consists of nothing more than a small piece of aluminium sheet, shaped to fit over one end of the transformer core, and held to it by means of two $\frac{1}{8}$ in. nuts and bolts. Since it was not

possible to put the bolts *through* any part of the transformer, recourse was had to sweating them on to the tinned steel outer case, after which the nuts were able to hold the "chassis" firmly on to the transformer. The small metal-cased electrolytic condensers are fixed to the chassis with home-made straps fabricated from thin tin, with further $\frac{1}{8}$ in. bolts soldered to them to enable them



Above—Circuit of the tuner, which is built on the larger chassis shown at the right in the photo of the previous page.

Right—Circuit of power supply and output stage, built on the small "chassis" attached to the power transformer.



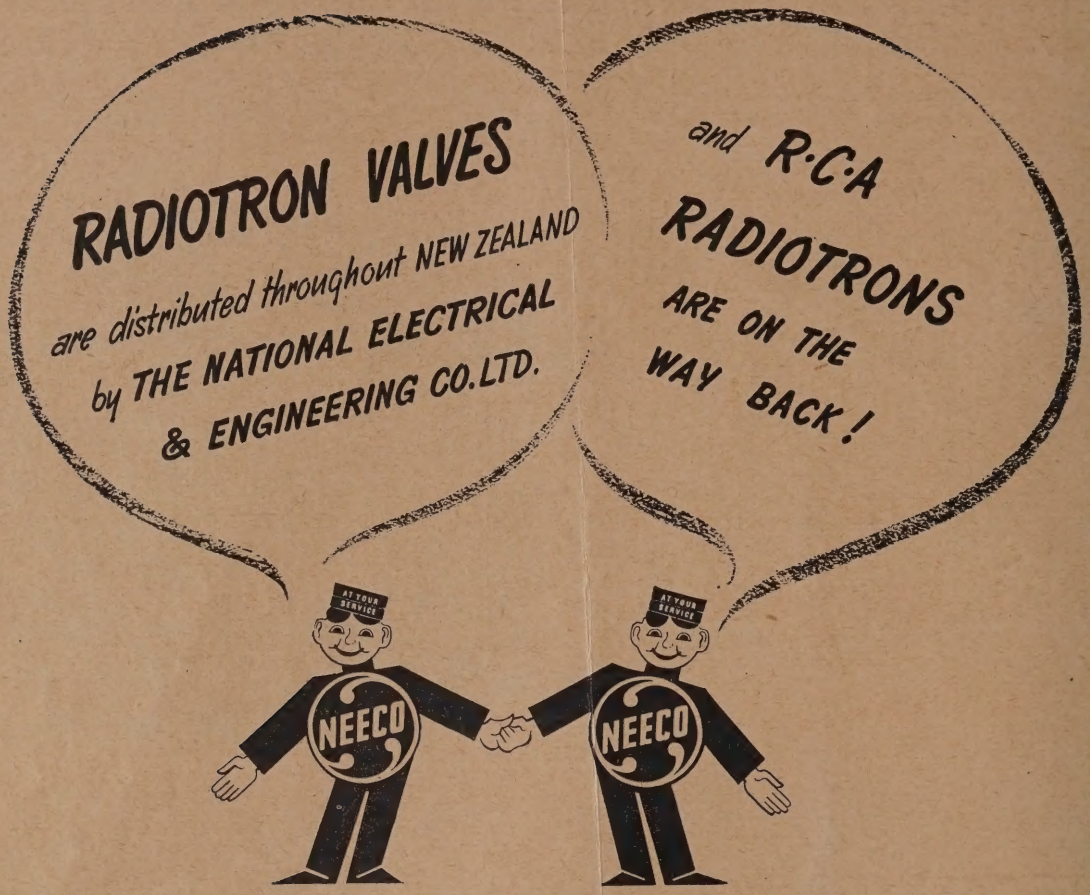
to be fixed to the chassis. This construction is shown by the photographs.

Some difficulty was experienced in deciding what to do with the volume control potentiometer, since it was desired to have its shaft come through the cabinet low down on the opposite side from the tuning shaft. It clearly could not be put on the power supply "chassis," and so it was decided to mount it directly on the transformer, taking flexible shielded leads to the tuner and the power valve respectively. Since these leads are shielded, there is no reason why they should not be made longer than strictly necessary, so that both units can be removed from the cabinet without having to unwire the volume control. This is of considerable assistance while the set is being served or aligned, because it was not found possible to place the I.F. trimmers, etc., in such a way that they would be accessible without taking the tuning unit out.

In order to use the smallest available power transformer, it was decided to run the valves at lower than normal plate and screen voltages. This has very little effect on the performance of the R.F. end, since the Rimlock tubes are designed to work well at low plate voltages, as well as at maximum. The chief limitation imposed by the decision was that the available power output is reduced. The EL42 is normally capable of two watts of audio output, and it was felt that this amount of power from a small set of this kind was neither necessary nor desirable. With the 150-odd volts available, the power output is reduced to something like one watt, and this is more than sufficient. Those who may doubt this statement need only remind themselves how much noise a portable can make, with a maximum output of less than 0.2 watts! Besides, it is unlikely that such a loud

this, the circuit is quite conventional in all respects, except perhaps one! On account of the low voltages, it was thought that it might be possible to dispense with normal biasing arrangements, and simply use the contact-potential of the A.V.C. diode as the sole source of initial bias for the mixer and I.F. stages. The output stage, of course, is cathode biased in the ordinary way. This scheme worked quite well. In order to use it, there was no question of using delayed A.V.C., and the old-fashioned simple A.V.C. circuit was employed. That is to say, the D.C. voltage developed by the detector diode is used as the A.V.C. voltage. This arrangement is frowned upon, and rightly so, by designers of high-quality sets, but of the U.H.F. signal to be reecived in most designs. turbances, in such a compact layout as this. Apart from noise of two watts would not result in microphonic dis-

(Continued on Page 33.)



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A Gramophone Pre-amplifier for the Audio Experimenter

This pre-amplifier has been designed for those who like to experiment with different pick-ups, and by means of simple switching, enables approximate gains of 100, 10, or 1 to be selected instantaneously. At the same time, bass compensation can be switched in or out of circuit without affecting the apparent volume.

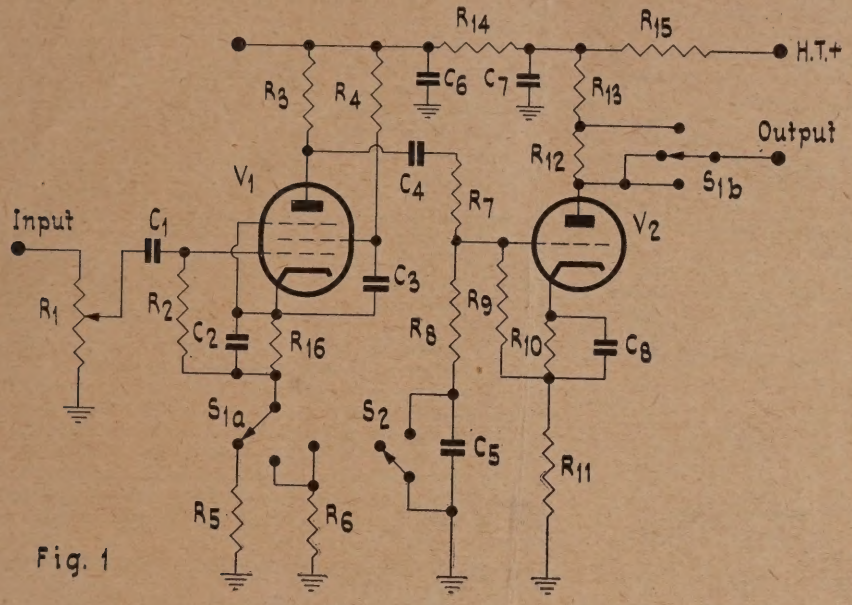

Fig. 1

COMPONENT LIST

R_1, 500k. pot.
R_2, R_9, R_7, 500k.
R_3, 250k.
R_4, 1 meg.
R_5, R_{10}, 2k.
R_6, R_{14}, R_{15}, 25k.
R_8, 50k.
R_{11}, 3k.
R_{12}, 100k.
R_{13}, 10k.
R_{16}, 900 ohms.
C_1, C_4, 0.005 μf.
C_2, C_8, 25 μf. 25v. electro.
C_3, 0.25 μf.
C_5, 0.01 μf.
C_6, C_7, 8 μf. 450v. electro.
V_1, 6SJ7.
V_2, 6J5.

INTRODUCTION

In these days, when there is quite a large range of gramophone pick-ups to choose from, it is often desirable to be able to feed one or another of several pick-ups into the same main amplifier, but the rather wide differences between the output voltages of these pick-ups make it inconvenient, and even impossible, to make the rapid substitutions that are often desirable, either for demonstration, or for comparison purposes, For example, some crystal pick-ups have outputs of several volts, and thus need no amplification at all before being fed to the main amplifier, even if certain frequency compensation is desirable. Other pick-ups, either crystal or magnetic, have outputs that can be directly applied to most amplifiers, as long as response compensation is not needed, but where compensation has to be applied, these same pick-ups do not give quite enough output. Other pick-ups still have outputs of only a few millivolts, and so need considerable amplification at all times.

It is these wide differences that often make it a task of some magnitude to try a new type of pick-up with one's amplifier. Very often, the problem is tackled in a very sketchy fashion by "haywiring" on to the existing amplifier an extra stage of amplification, by way of an outrigger obtaining its power from the main chassis. While such an arrangement can be satisfactory, it very often is not, because the temporary nature of the arrangement induces hum, or even instability. Then again, there is the difficulty of being sure that the temporary pre-amplifier is not being overloaded, owing to a mistaken idea of the output voltage from the pick-up.

The circuit described in this article represents an attempt to overcome the foregoing difficulties, and it is hoped that experimenters, and those who have cause to demonstrate different types of pick-up in rapid succession, will find it very useful.

SCHEME OF THE PRE-AMPLIFIER

The pre-amplifier contains two stages. V_1 is a 6SJ7 pentode, and V_2 is a 6J5. These stages are normal resistance- coupled amplifiers except that provision is made, with the first, for reducing its gain to 100 times, and then to 10 times, while in the 6J5 circuit, the gain is 10 times, but either the full output, or only a tenth of it, can be selected. In addition, there is a frequency compensating network between the two valves, which allows the necessary bass compensation for high-quality magnetic pick-ups to be cut in or out at will, without affecting the gain at middle and high frequencies. This network has an insertion loss of approximately ten times, so that the overall gain from input to output terminal is only a tenth of that actually provided by the valves.

This arrangement provides two useful facilities. First, the switch, S_2, enables bass compensation to be switched in or out. This is essential because only some pick-ups need this sort of compensation. Secondly, the ganged switches, S_{1a} and S_{1b}, are so arranged that the gain in the three positions is approximately 100, 10 and 1 respectively. The former figure is enough to provide an output of one volt from a pick-up whose output is a few millivolts. Since this is the lowest output one is likely to have under any circumstances, the pre-amplifier will handle the output of any pick-up at all.

CIRCUIT IN DETAIL

It would have been possible to allow both valves to work at their maximum gain at all times, cutting down the amplification by means of an attenuator between the stages, but this was not considered to be the best means of achieving the desired end, because valve gain, when not really needed, tends to increase the hum and noise level in the whole system. It is better practice to use only as much amplification as may be needed at the time, so that it was necessary to consider some means of cutting down the actual valve gain, without introducing too many complications. The scheme finally decided upon was to reduce the stage gain of the first tube by means of negative feedback. Accordingly, instead of returning the lower end of the cathode resistor to ground, an unby-passed resistor is placed in circuit between the bias resistor and earth. In order that this shall have no effect on the bias for the grid, the grid leak is not returned directly to earth, but to the lower end of the bias resistor. Indeed, the cathode circuit looks much like a conventional A.F. cathode follower. In position 1 of the switch, a 2000-ohm resistor is used. This reduces the tube gain from 165 to 100. In positions 2 and 3, a 25k. resistor is used, and this reduces the gain to only 10 times. The bass compensation circuit comprises R_7, R_8, and C_3, and is the conventional arrangement for giving approximately 6 db.

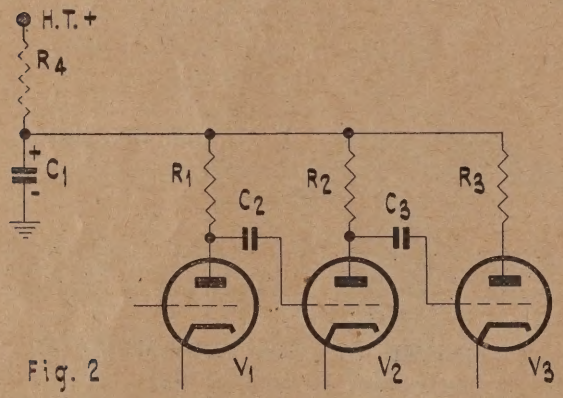

Fig. 2

per octave boost below 300 c/sec., in order to compensate for the fall in response of the record below this point. At middle and high frequencies, the condenser may be regarded as a short circuit, so that only one-eleventh of the output of V_1 is applied to the grid of V_2. Thus, if the condenser is short circuited by the switch S_2, there is no change in the effect at middle and high frequencies, but the boost at the low end disappears. Because of this effect, the effective amplification remains unchanged, whatever position the switch S_2 is in.

The circuit of V_2 is similar to that of V_1 in that here, too, use is made of negative feedback to reduce the stage gain. R_{11} reduces the gain from 14 times to 10 times. It would have been possible to omit the resistors R_5 and R_{11}, but had this been done, the overall gain would have been 131 times instead of 100 times, and, as we mentioned earlier, too much gain is a thing to be avoided.

USING THE PRE-AMPLIFIER

Since a device of this sort takes very little power from its supplies, it is desirable to run it from an existing power supply if possible, and this is most likely to be the one belonging to the main amplier. However, there is a catch here, in that unless care is taken, the results might not be at all satisfactory. The most likely difficulty is the possibility of low-frequency instability, or motor-boating, as it is colloquially called. This is due simply to having too many stages of amplification fed from an H.T. supply of only moderately good regulation. It is a feedback effect, which takes place because of the fact that the power supply does not have zero impedance. That is to say, as a source of voltage, it has an internal resistance, just as a cell or battery does, but considerably higher in value. This resistance does not appear on the normal circuit diagram, but it is there whether we like it or not, and unless its presence is recognized, and is allowed for by certain preventive measures, it can and will produce instability. Suppose, for example, that we have three amplifier stages whose H.T. voltage is supplied from the same point as in Fig. 2. C_1 is the last condenser in the smoothing filter, and R_4, shown dotted, is the internal resistance of the power supply. Now if C_1 were a perfect by-pass condenser, down to the lowest frequencies, all would be well, but as the frequency is lowered, there at last comes a point at which C_1 ceases to function properly as a by-pass, so that its presence can be ignored. In this event, we find that the internal resistance R_4 is in series with the load resistors of all three stages, and actually becomes a portion of each stage's load resistance. Let us suppose, for the sake of illustration, that the grid of V_1 is travelling in the positive direction. The plate of V_1 and the grid of V_2 will then be dropping in potential, while the plate of V_2 and the grid of V_3 will be rising. Now there is considerable amplification in the three valves, so that there will be a net fall in potential across R_4, owing to the fact that the fall at the plate of V_3 is much larger than either the fall or rise that occur because of V_1 or V_2 respectively. Thus, because of the presence of R_4, the fall in potential that is applied to the grid of V_2 is much greater than that due solely to the original signal. This is the same thing as saying that the circuit is regenerative, and if the effect is great enough, the circuit will oscillate. Now, as was indicated above, this effect only occurs at very low frequencies, where C_1 is ineffective as a by-pass. Thus, the resulting oscillation will be at a very low frequency—sometimes as low as one or two cycles per second, and when this is the case, the resulting oscillation is called motor-boating, for obvious reasons.

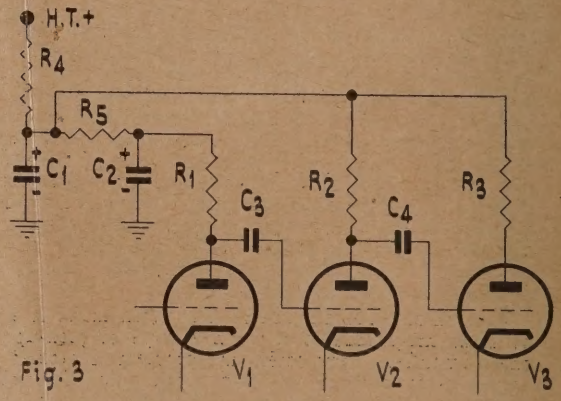

Fig. 3

COMBATING MOTOR-BOATING

The most obvious way of preventing this sort of instability is to have a power supply with little or no internal resistance, so that R_4 does not exist, or else is so small that the regeneration is not strong enough to allow oscillation to take place. However, this approach is not always practical, because it means (a) using a battery power supply; (b) using a regulated power

supply; or (c) using an entirely separate supply for some of the valves.

Another approach which will effect a cure in most cases is to use special de-coupling circuits. That is to say, the presence of R_4 is put up with, but measures are taken which prevent it from acting as a common load resistor for three or more stages. In the case of a pre-amplifier like this one, it will often be sufficient to insert a single de-coupling filter in the H.T. lead. This is because for regeneration of this kind to take place, *more* than two stages must be fed from the one H.T. point. With only two stages grouped, the feedback is degenerative, not regenerative, and can do no harm. In order to decouple the system shown on Fig. 2, only one resistor and condenser need to be added, and the circuit becomes as at Fig. 3 Here, the additional resistor, R_5, and condenser C_2, isolate R_4 from V_2 and V_3, so that the feedback can no longer occur, and the motor-boating is stopped. It will be noted, however, that in our circuit, we have shown decoupling filters in each stage. This is because even a decoupling filter cannot be perfect, and within reason, the more decoupling there is, the less the likelihood of instability occurring.

Another thing that can be of great assistance in preventing motor-boating when multiple stages have to be fed from the same supply is to ensure that the amplifier stages' response to extremely low frequencies is small. For example, no one is interested in making an amplifier respond well at frequencies below 10 c/sec., which is where practically all motor-boating occurs, so that if the stages are arranged so that their response falls off rapidly below the lowest audio frequency that is required, there will be much less chance of motor-boating. About all that can be done in this respect without too much complication, is to see that the low-frequency couplings are not TOO good.

LIMITING LOW-FREQUENCY RESPONSE

In order to illustrate what can be done in this respect, let us look at some of the usual values used in R.C. coupling circuits. For example, it is quite common to see a 0.1 μf. coupling condenser used with a 0.5 meg. grid resistor which has the following characteristics.

Frequency.	Response.
10 c/sec.	—0.4 db.
20 c/sec.	—0.15 db.
30 c/sec.	—0.05 db.

Now if three such couplings are used in the main amplifier, the response will be only 1.2 db. down at 10 c/sec., disregarding other effects such as screen by-passes in pentode stages, so that it can be seen that considerable amplification will be present at frequencies below this. If response at frequencies down to 30 c/sec. is the only consideration, then there is no need for such large couplings. In the main amplifier large couplings like this may be necessary for other reasons, outside the scope of this story, but the above illustration makes it abundantly clear that the coupling condensers can be made very much smaller without sensibly affecting the audio quality. For instance, if the condensers were reduced to 0.02 μf., the characteristic would look like this:

Frequency.	Response.
10 c/sec.	—5.5 db.
20 c/sec.	—2.1 db.
30 c/sec.	—1.1 db.

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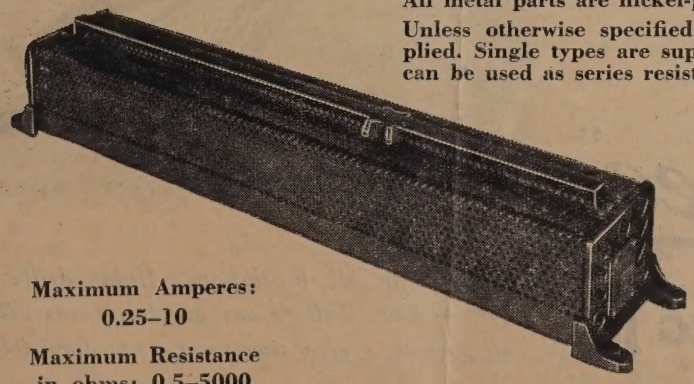

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This is for one coupling only, so that for three, the response would be 16.5 db. down at 10 c/sec., 6.3 db. down at 20 c/sec., and 3.3 db. down at 30 c/sec. This shows that the response at the dangerous frequencies below 10 c/sec. can be substantially reduced without affecting the response above 30 c/sec. to any significant extent.

For this reason, it is a good plan, especially in pre-amplifiers like the one described in this article, to see that the coupling condensers are not too large. This is especially important where, as here, a low-frequency boost circuit is used, because this accentuates the possibilities for motor-boating. The two coupling condensers have thus been made quite small, thereby assisting in low-frequency stabilization, without affecting the audible bass at all.

THE VOLUME CONTROL

Some readers may have wondered why we have started off the circuit with a volume control, when there is always one in the main amplifier with which the pre-amp. is to be used. The reason is that some means must be provided for ensuring that under no circumstances will the valves of the pre-amplifier be overloaded. The control R_1 can be used as an input voltage control, rather than a volume control, and can be set so that the signal applied to the input grid is never large enough to overload it, and run it into distortion. The surest way of making certain of this is to work with the amplifier main gain control as high as possible. It may not always be convenient to run with the amplifier volume control at maximum, because with the additional amplification from the pre-amplifier, there might be rather too much hum or noise, but one will soon get into the way of knowing how much output from different kinds of pick-up can be supplied to the pre-amplifier without running into distortion, and then the input control can be left set, and the amplifier main gain control used as a working volume control. From the point of view of least hum it is desirable to work with as much signal as possible into the pre-amplifier, short of overloading it. The hum problem will in any case only arise with very low-level pick-ups, and in this case, the whole output of the pick-up can be applied to V_1 by turning R_1 right up.

CRYSTAL PICK-UPS

For crystal pick-ups, the bass compensation will definitely not be needed. If, like high-quality magnetic pick-ups, crystal ones all had the same response curve, it would have been possible to insert a compensation network to take care of them, but the products of different manufacturers differ considerably in their response curves, so that the compensation required for every type is likely to differ from that for each other type. Accordingly, we have made no attempt to compensate for crystal pick-ups in the circuit itself. However, most of them have high output voltages, even when the recommended compensation has been applied, and, in addition, the networks recommended by the makers are intended to be connected between the pick-up and the first amplifier stage. Thus, for using the pre-amplifier with crystal units, our recommended procedure is to use the compensation circuit given by the maker, between the pick-up and the input terminal. Then, with the gain switched to

(Continued on Page 48.)

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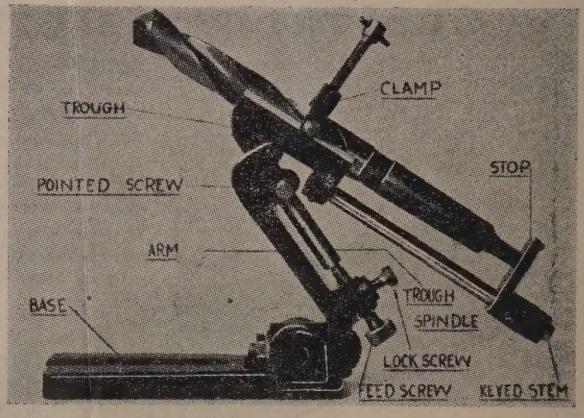

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The Airborne Magnetometer

By V. GERARD

Magnetic Survey Branch of Geophysics Division, Department of Scientific and Industrial Research

INTRODUCTION

In September, 1950, the Department of Scientific and Industrial Research with the co-operation of the R.N.Z.A.F. began an extensive aeromagnetic survey of the New Zealand thermal region as part of the present Geothermal Power Project. The airborne magnetometer used for the work is a British modification of one of the ingenious war-time "magnetic airborne detectors," intensively developed as anti-submarine weapons during the dark days of World War II, and although widely used in North America, this is the first time the instrument has been used in New Zealand. It is the purpose of this article to give a brief description of this interesting instrument.

Fig. 1—The Miles Aerovan which carries the magnetometer.

Firstly, however, let us see how a detailed knowledge of the variations of the earth's magnetic field can help the geophysicist. In elementary physics one is taught that the earth is a giant magnet with its poles at the North and South. It is this great magnet to which the magnetometer responds.

The earth's entire surface has a magnetic field which, in general, is most intense at the poles and weakest at the equator. But the field varies, slightly but measurably, from spot to spot because of variances in the earth's composition and structure. Charting these differences gives vital clues to the nature of geological strata. Sometimes the evidence is fairly direct—as when iron-bearing magnetic ore reveals itself by a magnetic "high", but usually it is circumstantial. In our thermal region, igneous or volcanic rocks give magnetic "highs" owing to their relatively high iron content; but these same rocks, if heated by thermal activity above the curie point of iron, would behave as ordinary sedimentary rocks which generally have a low iron content. Clearly then, the airborne magnetometer should be a valuable geophysical tool.

However, nearly all geophysical exploration techniques are being used in the Geothermal Project—the aeromagnetic survey being only one of several equally valuable methods.

The obtaining of geological informatoin by the measurement of magnetic variations is not actually new. It has been done on the ground for many years by the use of a magnetometer consisting basically of a loaded dip needle. The problem of making magnetic measurements in an aeroplane is an extremely difficult one for two main reasons: firstly because an aircraft has a large and often varying magnetic field of its own, and second, because it is extremely difficult to maintain any instrument in an aircraft in a fixed position relative to the earth. Gyros have not the necessary precision on the whole. The U.S. Navy solved the problem, and established the pattern for most subsequently developed airborne-magnetometers, by placing the sensitive part of the instrument in a bomb-shaped shell, usually called a "bird" and trailing it by a cable about 100 feet long. Stabilization was accomplished by means of an ingenious electronic mechanism which will be described later.

Fig. 2—The "bird" attached to the tail boom of the aircraft away from engines and other magnetic parts.

The general practice now is to select an aircraft with small magnetic fields and mount the "bird" in the tail. This has been done here where a "Miles Aerovan" aircraft, shown in Fig. 1, has been used. Fig. 2 shows a view of the rear of the aircraft with the bomb-shaped "bird", containing the magnetometer detector-head, fixed by means of a non-magnetic bracket to the tail.

THE FLUXGATE

The sensitive device used in the magnetometer to detect and measure the earth's field is called a fluxgate, and in its simplest form it consists of a mu-metal or permalloy strip surrounded by a coil of wire.

Fig. 3 (a) shows the fluxgate circuit as used in the New Zealand instrument. In this case the actual fluxgate can be regarded as the mu-metal cored coils, L_1 and L_2, together with the resistor, R. The 400 c/sec. current from the driving transformer is sufficient to run the cores of L_1 and L_2 well into saturation each half-cycle. The phase of the 400 c/sec. current in coil L_1 is slightly different from the phase of the current in coil L_2, because of the unbalancing resistor, R. Hence the A.C. magnetizing forces in the mu-metal cores, due to the respective currents, are not exactly 180° out of phase. It should be noted that the 180° shift of phase is produced by opposing the windings of L_1 and L_2 magnetically.

Let us first consider the case in which the ambient magnetic field, Ha, is zero. Fig. 3b shows the corresponding wave shapes. The changes in the flux density through the coress of L_1 and L_2 follow immediately from the

A.C. magnetizing forces and the hysteresis loop of the cores. Differentiating the flux density curve gives the electromotive force induced in each coil. The output electromotive force is the resultant of the two induced electromotive forces and, as can be seen, this consists of equal positive and negative pips. The unbalancing resistor R is made large so that the phase difference between the currents in L_1 and L_2 is small, hence no appreciable 400 c/sec. component appears in the output. If L_1 and L_2 are perfectly balanced electrically and R is infinite, then the output must be zero because the bridge is then perfectly balanced.

Now let us consider the case in which a small ambient field Ha exists along the axis of L_1 and L_2. It can be seen from Fig. 3c, which shows the corresponding wave shapes, that the origin of the hysteresis loop as seen by the A.C. magnetizing forces is shifted along the H axis by an amount equal to Ha. The resulting change produced in the output is such that the positive and negative pips are no longer of equal amplitude, as Fig. 3c shows.

By suitable electronic circuits outlined later, the differences in the amplitudes of the pips can be measured and recorded, giving a measure of both the magnitude and sign of the ambient field along the cores. Unfortunately this difference does not vary linearly with the magnitude of the ambient field. However, by means of negative feedback systems it is possible to make the variation linear over ranges sufficiently wide for magnetometer work.

SENSITIVITY

The sensitivity of a fluxgate is amazing. On the ground 10^{-6} oersted can be detected. This is equivalent to the field produced at the centre of a single layer solenoid of 25 turns per inch by a current of about 1/12 microamp flowing in it. In other words a fluxgate would make a good galvanometer, and without moving parts.

In the air a number of factors limit the sensitivity to about 2×10^{-5} oersted; but this is ample, for even a 10^{-4} oersted change in the earth's field is small from the geophysicist's point of view.

THE FLUXGATE STABILIZER DEVICE

Since the fluxgate is responsive only to the magnetic field component in the direction of its length, stabilization of the orientation of this fluxgate is necessary. If it were not stabilized, the angular motions of the aircraft would change the angle made by the fluxgate with the earth's magnetic field and consequently change the output signal. These changes would completely mask the small field changes it is desired to detect. The detector fluxgate is mounted in a gimbal arrangement embodying two axes of rotation at right angles. Rotations about the two axes are produced by two servo-motors controlled by the outputs of two auxiliary fluxgates mounted at right angles to each other, and at right angles to the detector fluxgate. Each stabilizer fluxgate controls one servo-motor so as to maintain itself at right angles to the earth's magnetic field, that is, in zero field. In this way the detector fluxgate is maintained parallel to the earth's field even during rapid movements of the aircraft.

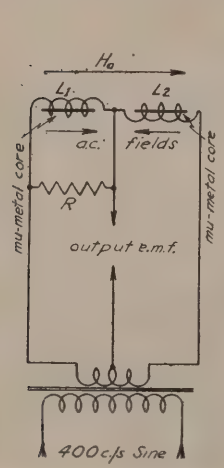

Fig. 3 (a)

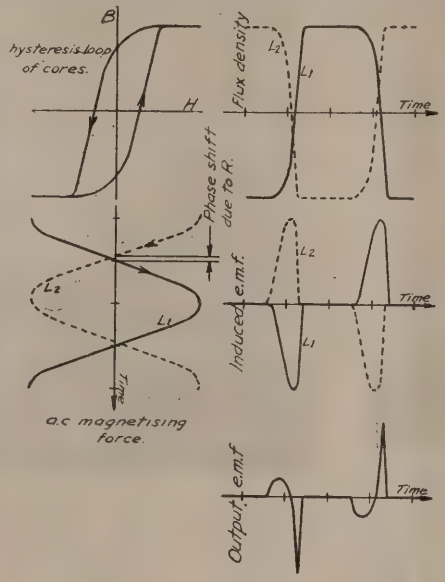

Fig. 3 (b)

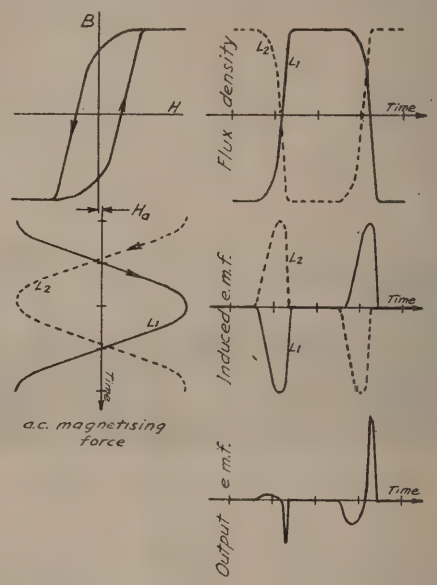

Fig. 3 (c)

BLOCK CIRCUIT DIAGRAM

As the magnetometer electronic circuits have 25 valves—mainly twin triodes—and all the usual associated components, it would not be possible to give a complete circuit diagram in this article, hence a block diagram, Fig. 4, has been drawn to show the main details.

The three fluxgates and the servo-motors are all supplied with power at a single frequency of 400 c/secs. which originates in a highly stable master oscillator.

The detector fluxgate driver is essentially a high quality push-pull power amplifier for furnishing the necessary driving power to the detector fluxgate. Means are provided (not shown in Fig. 4) for superimposing on the detector fluxgate a constant magnetic field, roughly equal, but opposite to the earth's field. Actually then, the detector fluxgate output is a measure of the difference between the earth's field and this constant superimposed field. The detector fluxgate output goes to the detector

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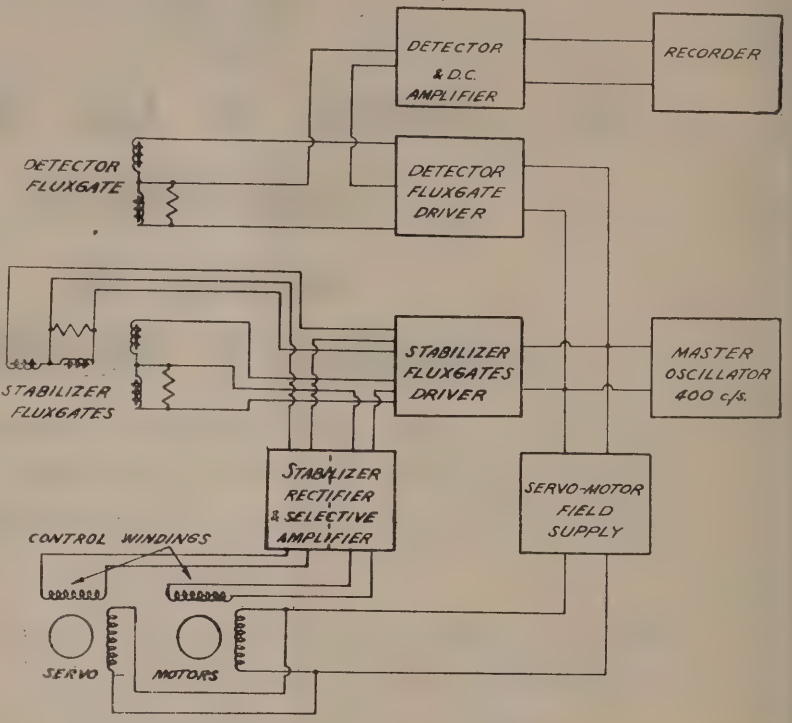
and D.C. amplifier. In the detector the positive and negative pips each go to peak rectifiers and the difference in the output of these rectifiers is amplified by the D.DC. amplifier. The D.C. amplifier is stabilized by a large amount of negative feedback, and its output operates the ink-writing recorder which writes a continual record of the magnetic variations encountered by the aircraft.

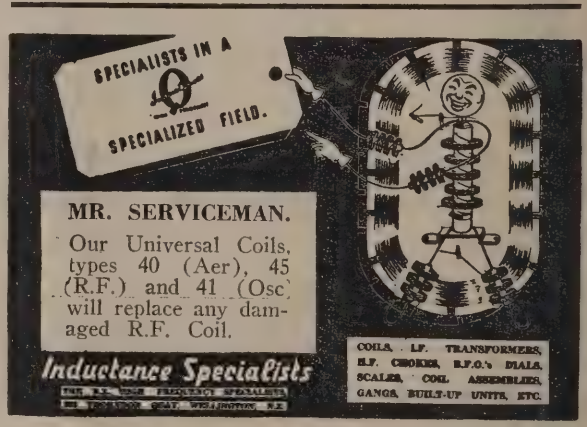
The stabilizer fluxgate driver which is similar to the detector fluxgate driver, supplies 400 c/sec. power to both stabilizer fluxgates. The output of each stabilizer fluxgate goes to one of the two identical channels of the stabilizer. In the first stage of each channel of the stabilizer, the output of the corresponding stabilizer fluxgate is rectified in such a way that the output of this first stage consists of a succession of voltage pips, all of the same polarity, instead of alternate pips being of opposite polarity. These pips occur at the rate of 800 per second. When the stabilizer fluxgate is in its normal position (in zero field) these pips all have the same amplitude; but if the fluxgate is turned through a small angle from its normal position, every other pip increases in size and the intermediate pips decrease.

The remainder of each channel of the stabilizer is essentially a selective amplifier tuned to 400 c/sec. Now when the stabilizer fluxgate is in its normal position the input to this selective amplifier consists of the equal amplitude pips, at the rate of 800 per second. This contains no sinusoidal component of lower frequency than 800 c/sec., so that the output from the selective amplifier is virtually zero. However, when the stabilizer fluxgate is not in its normal position, the input to the selective amplifier consisting of pips of alternately greater and lesser amplitude does contain a 400 c/sec. component, so that the output from the selective amplifier is no longer zero. In addition the phase of this 400 c/sec. output has one of two values, differing by 180°, depending on the sign of the stabilizer fluxgate orientation error.

The output of the stabilizer channel goes to the control winding of the respective servo-motor and controls its rotation. The field winding of the servo-motor is constantly supplied with 400 c/sec. power. When the stabilizer fluxgate is in its normal position, with no orientation error, the stabilizer channel gives no output and the servo-motor does not rotate. When the fluxgate is misaligned, the stabilizer channel provides 400 c/sec. power for the servo-motor control winding and the fluxgate is turned into alignment. The direction of rotation is controlled by the phase of the stabilizer output.

The two stabilizer channels operate independently without interaction, and maintain the detector fluxgate in a fixed direction even during quite rapid aircraft movements. The effectiveness of the stabilizer mechanism may be judged from the fact that in the laboratory stray 50 c/sec. magnetic fields caused the servo-motors to vibrate in an endeavour to align the fluxgates in the alternating field.

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FOR THE SERVICEMAN: Further information on Gulbransen 518N and Ultimate "RAW"

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TUBES (Five)—6BA6 R F Amp., 6BE6 Converter, 6BA6 I.F. Amp., 6AT6 Det. A.F., 6AQ5 Power output.
POWER SUPPLY—230 v A C Rating, 22 watts.
TUNING RANGE—Broadcast, 535-1625 K.C

ALIGNMENT INSTRUCTIONS

Set volume control at maximum and keep output from signal generator no higher than necessary to obtain output readings.

Dummy Antenna	Signal Generator Coupling	Sig. Gen. Frequency	Band Switch Position	Radio Dial Setting	Output Meter	Adjust	Remarks
1 mfd.	High side to pin No. 7 (grid) of 6BE6	455 Kc.		High freq. end	Across voice coil	A1, A2, A3, A4.	Adjust for maximum output
.1 mfd.	High side to ant. terminal	455 Kc.		600 Kc.	„	C18	Adjust for minimum output
R M.A.	„ „	1400 Kc.		1400 Kc.	„	C19	Adjust for maximum output
Standard	„ „	600 Kc.		Rock Variable	„	C17	Recheck C19 at 1400 Kc. If C19 is changed recheck C17

CAPACITORS

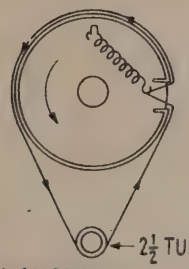
Ref. No.	Cap.	Volts
C1	50mfd	150
C2	50mfd	150
C3	8mfd	150
C4	25mfd	25
C5	.1mfd	400
C6	.05mfd	400
C7	.03mfd	400
C8	.02mfd	400
C9	.01mfd	400
C10	.005mfd	400
C11	.004mfd	mica
C12	.0005mfd	mica
C13-15	.0001mfd.	mica
C16	.00005mfd	mica
C17	600mmfd	padder
C18	3-30	trimmer
C19-20	Gang trimmers	

MISCELLANEOUS

Ref. No.	Res., Pri.	Res., Sec.	
193	.6 ohm	5.5 ohm	
793	.04 ohm	3.35 ohm	
953		33 ohm	
518N-1	6.75 ohm	6.75 ohm	
518N-2	6.75 ohm	6.75 ohm	
	Volts	**Volts**	**Volts**
TR5570	230	115	6.3
	Type	**Transformer**	
SP1	5" P M.	5000 ohm	
SW1	S.P.S.T. switch attached to R3		

RESISTORS

Ref. No.	Res.	Watts
R1	10 meg	½
R2	2 meg	½
R3	.5 meg	Tapped pot.
R4	.47 meg	½
R5	.1 meg	½
R6	.1 meg	½
R7	47,000 ohm	½
R8	47,000 ohm	½
R9	20,000 ohm	½
R10	15,000 ohm	½
R11	4,700 ohm	½
R12	4,700 ohm	½
R13	1,500 ohm	½
R14	600 ohm	½
R15	500 ohm	½



DRUM SHOWN WITH GANG AT MAX. CAP.

When replacing tubes this procedure must be followed to prevent damage to the loop and other delicate parts.

1. Disconnect the power plug from the 230v. supply.
2. Pull the knob and remove the central screw from the right-hand plastic cover.
3. Carefully remove the plastic cover and handle.
4. Lift the loop assembly and tilt it sideways until the tubes are accessible.

*** CIRCUIT ALTERATION**

Some receivers of this model were connected as shown in inset schematic diagram and could be changed with advantage of higher audio output to connections shown in the main diagram.

SPEAKER

The speaker used in this model is equipped with a low resonance cone suspension and high impedance transformer and should only be replaced with same type.

BASS COMPENSATION

High-level compensation has been obtained in this receiver by means of R5 and C8, while low-level compensation is obtained by use of a tapped potentiometer in conjunction with C7, C16 and R10. By use of both high and low level bass compensation, an unusually good tonal reproduction is obtained.

Technical Data on Ultimate Model RAW

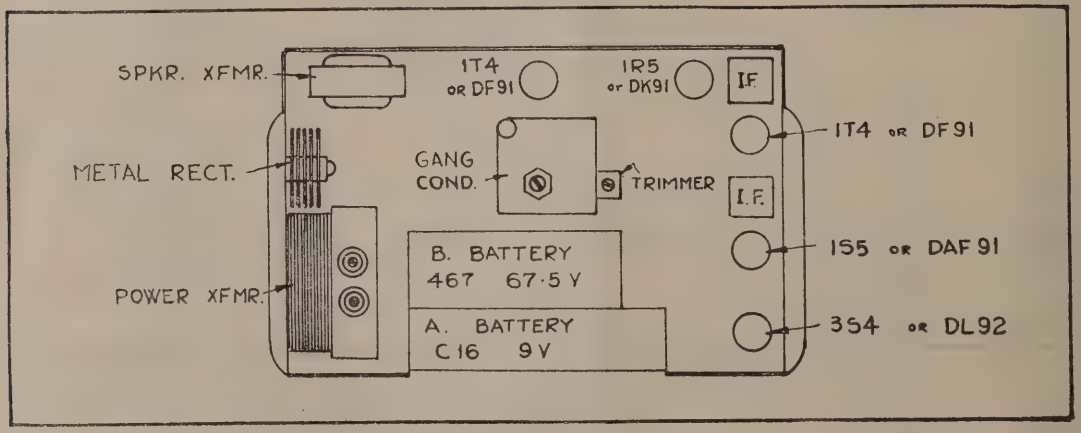
VOLTAGES APPEARING BETWEEN VALVE PINS AND CHASSIS FRAME.

VALVE PIN NO.	1.	2.	3.	4.	5.	6.	7.	8.
1T4 R.F. Amp.	+2.7	+63	+63	+1.9	0	+1.9	+3.9	
DK91 Freq. Changer	+1.35	+61	+61	−21	1.2	−.2	+2.65	
1T4 I.F. Amp.	+3.9	+63	+63	−.15	0	+3.5	+5.0	
1S5 Diode Det.	0	−.2	−.25	+17	+32	−.25	+1.35	
3S4 Power Amp.	+5.0	+61	−.2	+63	+6	0	+7.4	

Note: D.C. readings taken with vacuum type voltmeter. receiver on A.C. mains.

D.C. RESISTANCES.

Loop Ant.	1.5ohms	1st I.F. Primary	14.5
Det. Coil Primary	100ohms	1st I.F. Secondary	14.5
Det. Coil Secondary	4.5ohms	2nd I.F. Primary	14.5
Osc. Coil Primary	.75ohms	Speaker Xformer Primary	475ohms
Osc. Coil Secondary	2.0ohms	Speaker Xformer Secondary	.75ohms
Power Xformer Primary	210ohms		
Power Xformer Secondary	200ohms		



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Westinghouse Engineer, September, 1951, Westinghouse Electric Corporation, U.S.A. (H. W. Clarke (N.Z.), Ltd.).

Pamphlet "Tele-Amp," also sundry circuits and descriptive matter on S.O.S. receivers, kitsets, etc., S.O.S. Radio Ltd.

Top O "T" Moss—750 feet Television Mast at Holme Moss—Booklet by British Insulated Callender's Construction Co., Ltd. (National Electrical and Engineering Co., Ltd.).

Radiotronics, October, 1951, Amalgamated Wireless Valve Co., Ltd. (National Electrical and Engineering Co., Ltd.).

Prospectus, Electronic Navigation Ltd., Auckland, relating to the issue of 20,000 5 per cent. participating and 6 per cent. preference shares of 10/- each, the subscription list of which opened on 30th October, 1951.

Prospectus by the New Zealand Radio College, Auckland: new courses for marine radio operators, broadcast technicians, servicemen, etc., commencing 4th February, 1952.

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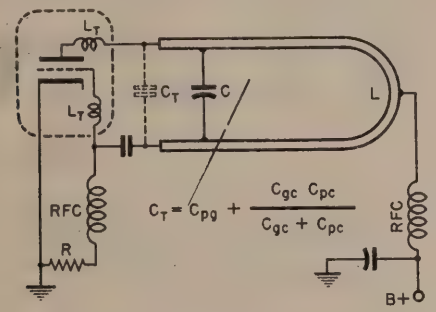
U.H.F. Receiving Tubes and Circuits

By the Engineering Department, Aerovox Corporation

In the past, commercial use of the ultra-high frequency portion of the radio spectrum (300-3000 mc/sec.) has been somewhat limited. Now, with the recent allocation of the 475-890 mc/sec. band for U.H.F. television, and the inauguration of the Citizens' Radio Service in the frequencies between 460 and 470 mc/sec., it is certain that this region will become increasingly active.

Since the vacuum tubes and associated circuitry employed at such frequencies, it should be valuable to review them at this time. This study will be confined to triode tubes of the conventional negative-grid type which are most likely to be utilized in receiving circuits for U.H.F. Television, Citizens Radio, and U.H.F. amateur communication.



TYPICAL UHF OSCILLATOR CIRCUIT
FIG. 1

In U.H.F. receivers of the superheterodyne type, it is usual that only the "front-end" tubes, i.e., the R.F. amplifier, mixer, and local oscillator are of special high frequency design. The other tubes and circuits beyond the mixer are usually of the low frequency variety. Similarly, in the superregenerative receiver only the detector and R.F. stage (if used) function at the carrier frequency. Actually, above 500 megacycles there are very few effective R.F. amplifiers available in the low cost field, and the function of mixing, or frequency conversion, is being widely assumed by the silicon crystal diode, since in this range it exhibits better noise performance than the vacuum tube as a mixer. Therefore, at the present time, tubes for local oscillator or superregenerative detector service are of primary interest as being the remaining tubes which must operate near the frequency of the U.H.F. signal to be received in most designs.

FACTORS LIMITING HIGH FREQUENCY PERFORMANCE

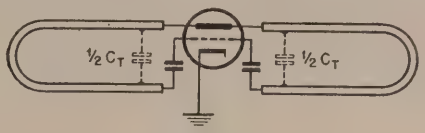
Receiving tubes of conventional design are not capable of satisfactory performance at ultra-high frequency because of several limitations which are inherent in their construction. Chief among these limiting factors is excessive interelectrode capacitance and inductance. That these quantities set a definite upper limit on the frequency of operation of a given vacuum tube design may be seen by considering the typical U.H.F. oscillator circuit of Fig. 1. In this circuit the frequency of oscillation is determined by the values of resonant circuit inductance (L) and capacitance (C) as related by Thomson's formula:

$$f = \frac{1000}{2\pi\sqrt{LC}}$$

Where:

f is the frequency of oscillation in megacycles.
L is the circuit inductance in microhenries.
C is the circuit capacitance in micromicrofarads.

From this equation it is seen that the frequency of the resonant circuit varies inversely as the square root of the product LC. For operation at frequencies above 300 megacycles, this product must be less than .28. However, as shown in Fig. 1, the inductance of the leads within the tube and the capacitance between the electrodes must be added to those of the external circuit. Thus, if an attempt is made to use a conventional receiving tube (such as a 6J5) at such frequencies, it will be found that the product of the capacitance of several micromicrofarads contributed by the tube and the inductance of the small wire leads which connect the elements to the base pins would be considerably greater than .28, even with the external circuit reduced to a direct connection between the grid and plate. Operation under this condition is sometimes called the "self-resonance" of the tube



R.F. CIRCUIT
OF DOUBLE-ENDED OSCILLATOR
FIG. 2

in manufacturers' data sheets, but does not represent a practical operating point since the efficiency of such a circuit would be very low, coupling would be difficult, and tuning nearly impossible.

TABLE I

TYPE	MAX. FREQ. MC.	DESIGN
958A	500	Acorn (Single-ended)
6N4	500	Miniature
955	700	Acorn (Single-ended)
316A	700	Door-knob (Single-ended)
6F4	1200	Acorn (Double-ended)
368A	1700	Door-knob (Double-ended)
2C40	3000+	Lighthouse

Another factor which prevents the efficient operation of common receiving tubes at the ultra-high frequencies is "transit time," or time required for an electron emitted from the cathode of the tube to reach the anode. For practical operation, this "time of flight" must be a small fraction of the period of one R.F. cycle—usually less than one-tenth. If it is appreciably longer, the output of the tube becomes small. This decrease in efficiency results from the fact that long transit time prevents the electrons from remaining in the proper phase to deliver maximum energy to the oscillating circuit. In other

words, with excessive transit time, the R.F. field between the tube electrodes may reverse while electrons are traversing these spaces, so that the electrons absorb energy rather than deliver it.

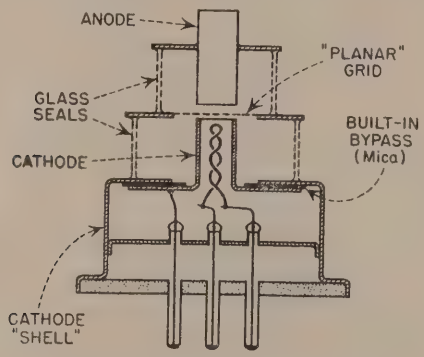
Excessive circuit losses also limit the use of standard receiving tubes to the lower frequencies. Such losses may take several forms, including:

(a) *"Skin-effect" losses.* Since ultra-high frequency currents flow mainly on the surface of metallic conductors, the resistance of the small wire leads usually used in tubes is very much greater at these frequencies than at lower frequency.

(b) *Circuit radiation losses.* At U.H.F. wavelengths, even a short length of wire may radiate considerable energy. Tube leads, unless spaced close to others carrying out-of-phase currents, will cause R.F. radiation losses which reduce efficiency and output.

(c) *Dielectric losses.* The standard bakelite bases and glass "presses" used in most receiving tubes are too lossy for use at U.H.F. Such poor dielectrics, especially if they occur where electrostatic fields are strong, absorb R.F. energy which is converted to heat. The process is cumulative, since the dielectric losses increase with temperature.

The combined result of the foregoing effects is to cause the efficiency and power output of conventional receiving tubes to drop to impractical values at frequency limits below 100 mc/sec. for most designs. Even many tubes in the miniature and sub-miniature classes are limited to frequencies below 300 mc/sec. by these same effects, unless special precautions have been taken in their design.



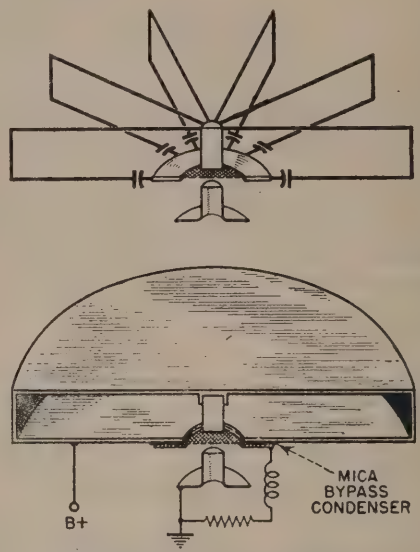
SHOWING CONSTRUCTION OF "LIGHTHOUSE" TRIODE

FIG. 3

SPECIAL U.H.F. DESIGNS

Table I lists some of the readily available tubes which are effective in at least the lower portion of the U.H.F. band currently of interest. In these tubes, the limitations discussed above have been reduced by special design features. We will now discuss these features.

Transit time may be reduced in a vacuum tube by decreasing the spacing between the elements or increasing the plate voltage so that the electrons move faster. The former is the best approach in receiving tubes, however, since plate voltage must be quadrupled to double the velocity of the electrons. Thus, rather high voltages would be required to achieve U.H.F. operation. It is usually more convenient to reduce the electrode spacing. This, of course, has mechanical limitations, since the grid-to-plate spacing if the tube is to have a sufficiently high amplification factor (mu.). In most U.H.F. triodes, the grid-cathode spacing is only a few thousandths of an inch for these reasons, and is less than .001 inch for one special triode tube.



DEVELOPMENT OF "LIGHTHOUSE" TUBE CAVITY OSCILLATOR FROM "MULTIPLE-ENDED" CIRCUIT

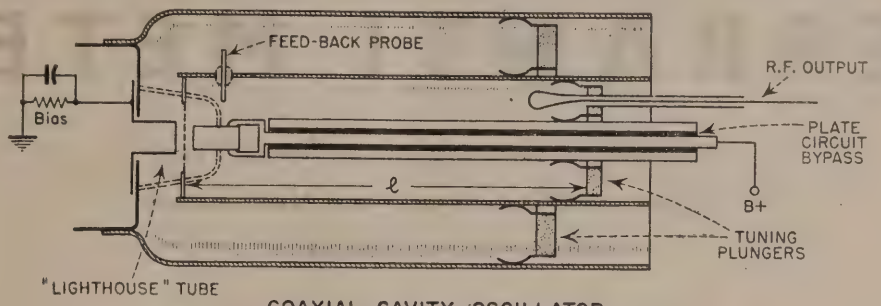
FIG. 4

It will be readily seen that the reduction of element spacings in the vacuum tube to reduce electron transit time has an adverse effect upon the inter-electrode capacitance. As the elements are moved closer together, the capacitances between them increase proportionately. This, of course, reduces the maximum frequency of operation as shown by Eq. 1. The only recourse which the tube designer has in this case is to reduce the area of the tube electrodes to keep the tube capacitances within usable limits. This necessity, in turn, limits the power handling capabilities of the tube by reducing the anode heat dissipation and cathode area. Such considerations explains why the generation of radio frequency power becomes increasingly difficult as the operating frequency is raised.

Tubes of the "acorn" type (955) and the "door-knob" type (316A) represent about the best that can be done by the simple expedient of reducing tube dimensions to minimize transit time, lead inductance, inter-electrode capacitance and dielectric losses. Such tubes function up to about 700 megacycles as stable oscillators. Beyond this frequency limit, tubes which are adaptable to special circuits must be used.

A considerable increase in the upper frequency limit is achieved by the "double-ended" circuit shown in Fig. 2. In this arrangement, the tube is provided with dual grid and plate leads and a separate resonant circuit is connected to each pair of leads. The tube capacitance is now part of two resonant circuits and may be thought of as being shared between them. Therefore, each resonant circuit has only half of the effective capacitance value that the same tube would add in the circuit of Fig. 1. For this reason, the size of each of the inductances in Fig. 2 would be considerably larger for operation at the same frequency, or would permit operation at consider-

ably higher frequency before becoming impractically small. Another way of considering this extension of frequency limit is by noting that the two inductances are now in parallel, which reduces the effective value which resonates with the tube capacitance to approximately one-half. This lower value of inductance, when substituted in Eq. 1, gives a much higher frequency. Another advantage to the use of the double-ended circuit results from the fact that the oscillating R.F. currents



COAXIAL CAVITY OSCILLATOR
FIG. 5

divide equally between the two circuits so that skin-effect losses are considerably smaller.

The 6F4 and the 368A are examples of tubes having double-ended construction. The 6F4 is a triode of the "acorn" type with dual grid and plate leads which is especially well adapted to local oscillator service in the U.H.F. television band. It has an upper frequency limit of about 1200 mc/sec. The 368A is a larger tube of the "door-knob" type, operable to 1700 megacycles.

During World War II, a substantial advance in the high frequency performance of conventional triode tubes was made by the introduction of the planar-grid "lighthouse" tube. The general construction of this tube family is illustrated in Fig. 3. Tubes of this type, such as the 2C40, serve as grounded-grid amplifiers and oscillators at frequencies exceeding 3000 megacycles.

The improved performance of the lighthouse tube is due to the novel construction employed. The use of "disk-seals" and planar (or flat) cathode, grid, and plate elements permit the factors which usually limit triodes to be reduced to a minimum. This feature was made possible by the development of special metal-to-glass sealing techniques. Lead inductance is extremely low because wire leads connecting the tube electrodes to the external circuit have been replaced by flat metal disks which extend radially from the tube elements through the glass seal. Inter-electrode capacitances are very low because the effective heat dissipation of the disk-seals makes the use of small plate and grid areas practical. A good example of the increase in electrode cooling by thermal conduction through the disk-seals is readily seen in the comparison of the rated maximum plate dissipation of the radiation cooled 955 and the conduction cooled 2C40. Although the 955 has a larger active plate area, it is rated at only 1.6 watts dissipation, whereas the 2C40 plate will dissipate over 6.5 watts because of heat conduction through the seal to the external circuit. Losses due to "skin effect" are also minimized in the lighthouse type of construction since the surfaces connecting the tube electrodes to the external circuit are large and are silver plated, for better R.F. current conduction.

The lighthouse tube, or so-called megatron, was especially designed for use in coaxial or cavity circuits. It may be used in lumped-constant and parallel-line circuits at the lower U.H.F. frequencies, but in such applications its full capabilities are being wasted. The advantages of the disk-seal construction, enumerated above, are only realized in cavity or coaxial circuitry which makes intimate electrical and thermal contact with the entire outer edge of the disk-seals. The evolution of a simple cavity oscillator circuit from the single and double-ended circuits of Figs. 1 and 2 is shown in Fig. 4. Thus, the cavity circuit may be thought of as a "multiple-ended" circuit in which the number of resonant circuits connected in parallel is made infinite so as to form a solid wall completely enclosing the R.F. fields. In such circuits the losses due to radiation are very small. A special by-pass condenser is built into the base of the tube to block D.C. bias voltages but connect the cathode "shell' to the cathode for R.F.

A more practical circuit of the coaxial type is illustrated in Fig. 5. This arrangement uses two resonant coaxial circuits; one connected between the grid and cathode, and the other between grid and plate. The circuit is therefore analogous to the tuned-plate, tuned-grid circuit. Because the grid is at R.F. ground, and forms an effective electrostatic shield between the input and output circuits, the circuit will not function as a self-excited oscillator unless feed-back is intentionally introduced by coupling between the two cavities. Without provisions for R.F. feedback, the circuit functions as an effective grounded-grid amplifier. Tuning is accomplished in coaxial circuits by means of movable shorting "plungers" which vary the length of the coaxial resonator, and hence the resonant frequency, which is related to the length of the resonator by the expression:

$$\frac{1}{\omega C_o} = Z_o \tan \frac{2\pi l}{\lambda}$$

Where:

C_o is the tube capacitance shortening line.

ω is 6.28 times the operating frequency.

Z_o is the surge impedance of line.

l is the length of the line.

λ is the wavelength.

2π is 360 degrees.

This equation may also be used to determine the approximate length of the parallel line resonant circuits used with single-ended and double-ended oscillator circuits. In the latter case, it must be remembered that only one-half of the lumped capacitance contributed by the tube is used in Eq. 2.

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In practice, of course, the job will eventually devolve itself onto some unsuspecting serviceman, who will have to figure out how two terminals labelled "extension loudspeaker" and a couple of bits of wire work the oracle. In all probability he will finish up by making completely different arrangements to the set in such a way so as not to offend his sense of what is technically correct. The only really satisfactory way of running the other speaker is from the secondary side of the set output transformer —the leads will then be at low impedance and will not be affected by reasonable length or position nor will they carry high voltage. At the same time a switch should be provided so that either the set speaker or the remote speaker may be selected at will but not both together unless proper matching taps are provided on the output transformer to cope with the change of impedance.

All this would seem a very easy thing to do and all rather obvious; but it is surprising just how many commercially built sets fall down on this point.

One very common method adopted by manufacturers is to connect the extension loudspeaker terminals to the plate of the output valve through a condenser having a value of .1 μf. or thereabouts. This arrangement scores from the point of view of cheapnesss, but that is about all. The person who buys the set may one day purchase one of the made-up extension loudspeakers available in the shops to find when he connects it up that the set goes almost completely dead, or at least very "wooffy" with a .1 μf. condenser from the plate of the output valve to earth. As far as the extension speaker is concerned, it maintains an aloof silence. The answer, of course, is that the new speaker needs an output transformer on it to work under those conditions, and even then the best that can be hoped for is that the mismatch will not be too noticeable. However, this arrangement can still bring other troubles in its train as the writer discovered one day. A friend of a friend toted along his tale of woe—he had recently shifted to a new house and found that his set performed horribly in the new place, would I mind, etc., etc. To cut a long story short, examination of the radio showed that the owner had an extension speaker connected and was running high impedance lines to the remote speaker, which, however, was terminated with a transformer. The length of line was such that the set was oscillating violently above audio frequency sufficiently to choke the output stage and produce most unpleasant results. The owner was informed that he couldn't do that there here, to which he replied that he'd done it in his other home and it was quite alright! This caused a nasty moment until he had to admit that his speaker lines had been shorter in the other home. However, not liking the idea much, the extension speaker was rearranged to work via a local-remote selector switch on voice coil lines and everything turned out beautifully. We were even able to present the owner with one surplus output transformer from his remote speaker which he accepted with great suspicion. The only unsatisfactory aspect of the job was that the speaker had a very elementary volume control which, however, appears to be the rule on present-day extension speakers. The correct method to control volume under these conditions is to provide a proper constant impedance pad so that the load presented to the output valve is unvarying for different volume settings. Where an ordinary type of potentiometer is employed as a volume control it is wise to connect a series resistance of low value with the pot. to ensure that the speaker lines are not shorted out or otherwise to fit a stop on the potentiometer before it is turned completely off. The worst is yet to come, however—just wait till your future customers want an extension television tube fitted!

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Avoid Bother with Baggage

Proceedings of the New Zealand Electronics Institute (Inc.)

Headquarters News.

The last meeting of the Executive Council of this Institute was a novel departure in that the meeting, instead of being held in Wellington as in the past, was held in Christchurch. This enabled Christchurch, Dunedin, and Wellington delegates to get together on several important matters, and it was only by mischance that Auckland was unable to be represented.

Grants to Institute

From the report received from the special sub-committee headed by Mr. Collier, it would seem that the appeal issued by the Institute to firms for financial assistance is being very favourably reecived. An intimation was given by Mr. Collier that two firms approached by him had promised support, and the Secretary advised that a donation of £25 had been received from Radio (1936) Limited during the current month. A suitable resolution of thanks was recorded in the minutes for this most generous gesture.

Brochures

Those associated with the Institute may not be aware that brochures, incorporating an application for membership form, have been printed and made available for distribution to prospective members. Should any individual require a copy of this brochure it will be forwarded to him on a request being made to the Secretary, P.O. Box 1368, Wellington.

Report to Council by the Papers Sub-committee

A very long report was submitted by the Papers Sub-committee covering the importance of publishing papers, the methods of obtaining such papers, and the encouragement to be given to members to produce and submit technical articles. A lengthy discussion ensued on the principles enunciated by the sub-committee responsible for the production of the report and the report itself was finally referred back for further investigation and submission in such form that it could be published in the proceedings of the Institute.

It was also felt that the Committee should draw up definite conditions governing the award of prizes for the best papers submitted, and further details governing this matter will, therefore, be published at a later date.

Rutherford Memorial

Much progress has been made respecting the appeal issued by the Rutherford Memorial Committee, with which this Institute is associated. At its meeting in Christchurch, Council agreed that the cause was a most worthy one and that every encouragement should be given to members to associate themselves with the appeal and if possible to make private donations.

Audited Statement of Accounts for the year ended 31/3/1951

Councillors present at the meeting perused the audited statement of accounts, which may be made available to any member for perusal if he cares to call at the Institute office, A.M.P. Building, Wellington.

Proposed Amendment to Rules

Considerable discussion ensued following a proposal by the Dunedin delegates that the rules should be amended to permit of the introduction of a membership grading for those passing the Institute examinations or equivalent examination. The title proposed for such members was that of "Graduate" and it was also felt that those members aspiring to the election of "Associate" should be granted this opportunity under less rigid conditions than those prevailing at present. The matter was finally referred back to a special sub-committee appointed from Council to deal with the matter.

Demonstration of Television

Prior to the meeting, Council delegates attended a demonstration of television in the Electronics Laboratory of Canterbury University College. Members present were televised and in addition an inspection of the equipment available in the Electronics Department at Canterbury College was carried out under the guidance of Christchurch representatives to the Council.

At the meeting the following members were elected:

AM 69 Reginald Lorenzo Guthrie, Aeradio Station, Faleolo, Western Samoa, Associate Member.

A 154 Edward Samuel Stewart, 48 Ilam Road, Riccarton, Associate.

S 193 Graeme Frederick Thomas Todd, 106 Totara Street, Riccarton, Student.

Transfer from grade of Student to that of Associate Member approved:—

A 156 Jeffrie Gavin Walker, 30 Cranley Street, Tainui, Dunedin, E.1. Associate.

A cordial welcome is extended to these new members and congratulations extended to Mr. Walker on his promotion in status.

Branch News

Due to the Christmas holidays there has not been a great deal of activity in the branches, but for the general information of members the following is a brief summary of branch activities.

Wellington

Members are reminded of the talk to be given by Mr. D. Ironside on 17th January, bearing the title "Pick-up Equalizers." The hall in which this lecture is to be delivered is not yet fixed, but any member desirous of attending may obtain further information from any of the officers whose names are listed below. The publication of these names may possibly help members who are desirous of obtaining information regarding Wellington Branch activities.

(Concluded on Page 48.)

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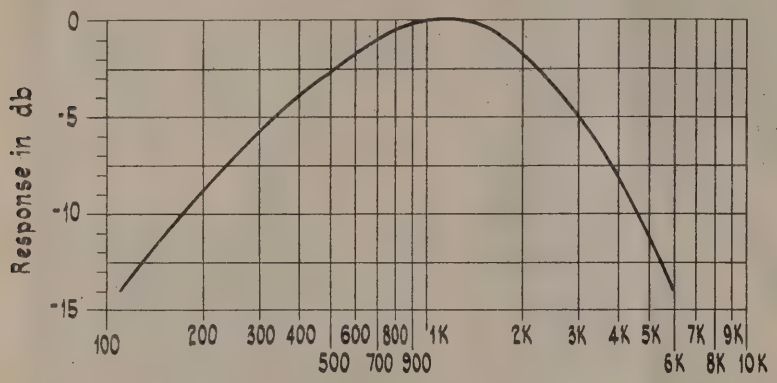
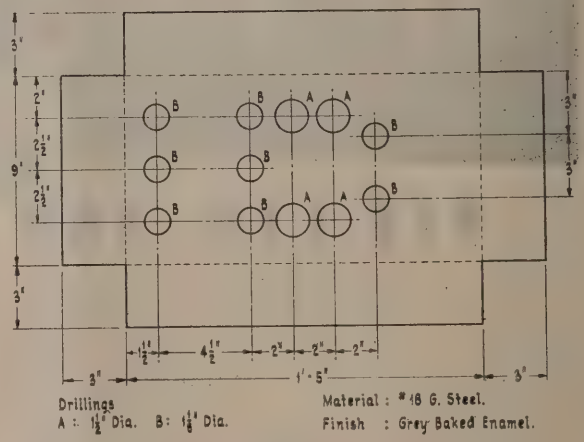
Continuing the description of the pre-set controls and their purposes, we come now to C_{26} and L_1. These, together with the resistors R_{48} and R_{50} make up two phase shift networks, each placed between the R.F. input terminal and the input of one of the balanced modulators. It is well known that in a circuit containing equal resistance and reactance in series, the voltage across the reactive component is 45 deg. out of phase with respect to the input voltage. In the case where the reactive element is an inductance, this 45 deg. phase shift is a leading one, while a capacitive element produces a lagging voltage, again 45 deg. out of phase. Thus there is a phase difference of 90 deg. between the R.F. voltages applied to the two modulators. From the practical point of view, the important thing is that the reactances should be equal to the resistances. If this is not so, there will still be a phase difference between the R.F. inputs, but it will no longer be 90 deg. It is essential, therefore, that both the inductance and capacity should be variable. Once they have been set, for a given radio frequency, there is no need to change them unless the frequency is altered. In practice, their adjustment is not particularly critical, and the same setting will do for the whole of the 80m. band. Moreover, should it be desired to use the exciter on other bands, such as the 40m. or 20m 'phone bands, it will be necessary to provide different values of L_1 and C_{26}, which can be pre-set, and selected by means of a switch.



Frequency response of the audio section of the exciter.

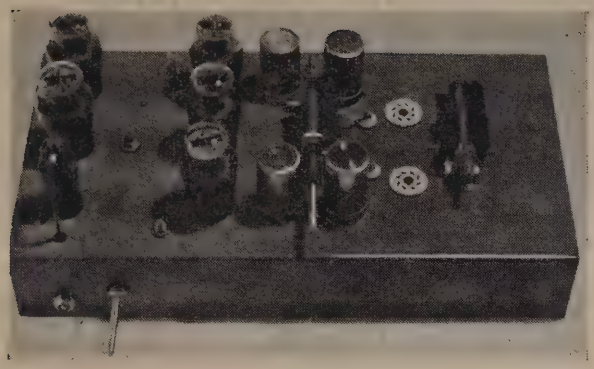
CONSTRUCTION OF THE UNIT

There should not be much need to say a great deal about the construction used for the unit, since the bulk of it follows normal audio frequency layout and wiring techniques. A chassis diagram showing the layout used in the completed exciter will be found on this page, together with photographs of the finished article. Only the main (valve) holes have been shown on this diagram. At the left of the chassis is a row of valves starting in the front corner with the Philips EF37A pre-amplifier. Behind this is the first Philips ECC34 comprising V_2 and V_3 of the circuit, and behind it again is the second ECC34, V_4 and V_5. The remainder of the valves follow exactly the arrangement shown in the lower half of the circuit. The four EF50s can easily be recognized, grouped round the plate tuning condenser, C_{28}. The middle of the three ECC34s contains the sections V_6 and V_7, while the other two are the push-pull amplifiers whose plates are directly coupled to the screens of the EF50s. The two unused sockets to the right of the balanced modulators are for future use, since once the exciter proper is completed, as shown in the photographs, the next step is to add a pair of Philips EL37s as a Class A push-pull amplifier, thus providing useful power, either to feed to the aerial, or for exciting a high-powered stage. The tuning condenser for the EL37 stage has been mounted, and can also be seen in the top-chassis photograph. Space has been left on the chassis for the tuning coil for the EL37 stage to be mounted above the chassis. The coil for the modulators can be seen in the under-chassis view.



Working drawing for the chassis showing valve holes.

The phase shift network has been built on a small piece of sheet celluloid, and this is mounted to the chassis by a bolt, approximately in its centre. The assembly can be seen on the under-chassis photo, which has been turned upright to save space. The front edge of the chassis is at the left in this picture, and the audio input socket and gain control potentiometer can be seen on that side. The three pre-set potentiometers can be seen in this view.



R_{37} is the middle one, while R_{41} and R_{46} are near their own valves at the sides of the chassis. On the right of the photo, which is the back of the chasis, can be seen the coaxial input connecter. From it at right-angles come the two large resistors R_{48} and R_{50}. These are each two 570-ohm 1-watt resistors in parallel, giving a power rating of something over 2 watts, which is necessary on account of the fact that some power has to be dissipated in them in order that a high enough excitation voltage for the EF50s may be built up across the inductor L_1 and the condenser C_{28}. Further, these resistors should run cool in order that their values will not change appreciably.

TABLE OF VALUES

A list of the component values could not be included in Experimenter No. 50 on account of space limitations, and so it has been printed in this issue. If the best results are to be had, certain of the parts should be chosen to fairly close tolerances. This applies more especially to the condensers and resistors of the phase shift network. In the prototype, the values were chosen to be correct to within 2 per cent. and it was found that this gave quite acceptable performance, though very slightly better results might be obtained by working to still closer limits. Intending builders might have some difficulty in obtaining the required capacities in the tolerance required, so we have made arrangements to supply to those who want them, sets of resistors and condensers for the phase shift network, specially chosen to the required values. The price for the six resistors and six condensers will be 37s. 6d. It will be understood that this price is very largely taken up by the work involved by hand-picking combinations of condensers to give exactly the right values.

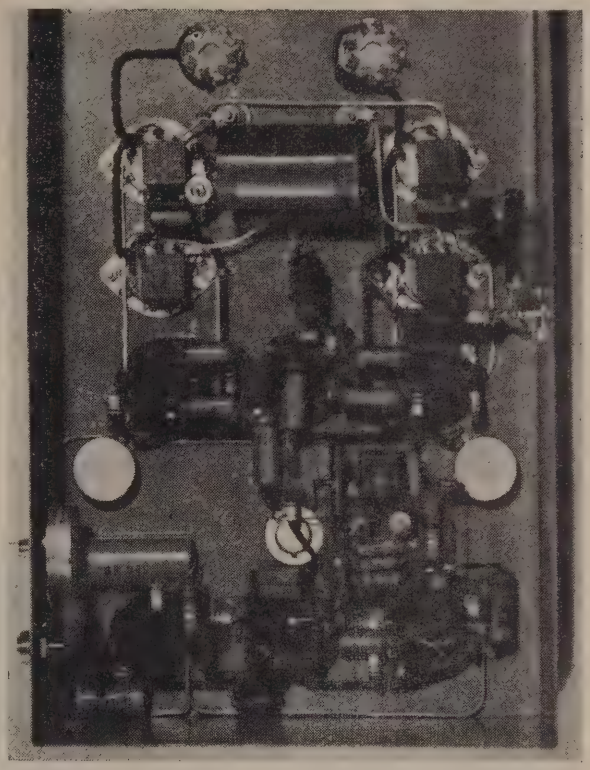
Although there is no absolute necessity for the other parts to be specially chosen, it will pay, where possible, to match the values of certain of the resistors. This applies to the plate and cathode resistors of the three phase inverters. The balance of this type of inverter depends solely on the accuracy to which the plate and cathode load resistors are matched. These are specified as 50k. each. The actual value is not critical, and can well come within the normal 20 per cent. tolerance, but the matching between pairs belonging to each valve should be as close as possible. For matching purposes, an ohm-meter will be quite satisfactory, as long as the meter deflection is not so near the end of the scale that reasonably small differences cannot be detected.

(Continued on Page. 48.)

COMPONENT LIST

R_1, 500k. pot.
R_2, 240k.
R_3, R_6, R_{13}, R_{11}, R_{28}, R_{30}, R_{36}, R_{37}, R_{38}, R_{39}, 1 meg. ½ watt.
R_4, R_7, R_{15}, R_{18}, R_{33}, R_{34}, 3k.
R_5, R_{20}, R_{21}, 15k. (R_{20} and R_{21} to be within 2%)
R_8, R_9, R_{12}, R_{16}, R_{17}, R_{29}, R_{31}, R_{32}, R_{44}, R_{46}, 50k. R_{33}, R_{10}, R_{42}, R_{23}, R_{24}, 50k. (2%).
R_{10}, 150k.
R_{13}, 5k.
R_{19}, R_{22}, 100k. (2%).
R_{25}, 500k.
R_{26}, 1.5 meg.
R_{27}, 2 meg. pot.
R_{43}, R_{47}, 1500
R_{48}, R_{50}, 285 ohms, 2 watts (each two 570-ohm 1-watt in ½ parallel.)
R_{49}, R_{51}, 10k.
C_1, C_7, 25 μf. 25v. electro.
C_2, C_4, C_6, 0.002 μf.
C_3, 16 μf. 450v. electro.
C_5, C_8, 500 μμf.
C_9 C_{10}, C_{18}, C_{19}, C_{20}, C_{21}, 0.05 μf.
C_{11}, C_{13}, 0.1 μf.
C_{22}, C_{23}, C_{24}, C_{25}, C_{27}, C_{30}, 0.001 μf.
C_{26}, 100 μμf. with 3–30 μμf. trimmer in parallel.
C_{28}, 100 μμf. per sec. split stator.
C_{12}, 0.001 μf.
C_{14}, 0.0285 μf.
C_{16}, 0.0021 μf.
C_{17}, 0.0095 μf.
C_{29}, 0.0063 μf.
Note: These values to be correct to within 2% or better.

L_1, L_2, see text.
L_3, 2.5mH. R.F. choke.
V_1, EF37A.
(V_2, V_3), (V_4, V_5), (V_6, V_7), (V_8, V_9) (V_{10},V_{11}), ECC34
V_{12}, V_{13}, V_{14}, V_{15}, EF50.



NEW ZEALAND RADIO TRADERS' FEDERATION

REPORT OF DELEGATE ON RADIO INTERFERENCE STANDING COMMITTEE

I enclose herewith a copy of the minutes of a meeting of the Radio Interference Standing Committee held at the General Post Office, Wellington, on 20th September last.

Only very brief reference is made therein to the matters raised by each delegate, and so for the benefit of members and as a record of matters raised on behalf of the N.Z.R.T.F. the following may prove useful.

Your delegate made strong reference to several prevalent forms of radio interference, viz.:

1. Widespread interference from fluorescent lighting.
2. Bad interference from jamming by tramway trollys in Wellington.
3. Severe interference from trolly buses in all towns where these are currently used.
4. The need for more rigid control over the sale of interference-producing devices, including ultra-violet lamps.

Your delegate also stressed the need and urgency of closer co-operation between officers of the P. and T. Radio Section and radio traders throughout New Zealand. No attempt had yet been made by P. and T. officials to have reports on radio interference submitted by radio servicemen, many of whom could help in the general cause. The suggestion was made that the P. and T. provide all radio dealers with a quantity of forms for the use of their servicemen who could report on any strong interference noted in the course of service calls. It was stressed by your delegate that these reports, being entered by responsible men, could save much of the time of inspectors in investigating false or misleading reports from users and could also prove of immense value in the overall reduction of interference levels.

It was also suggested by your delegate that radio inspectors should address gatherings of radio dealers at the regular or special meetings when the trade could be informed of steps being taken to overcome interference and ways, suggested by the departmental officers, by means of which radio traders could co-operate.

Both of these suggestions were enthusiastically received and the P. and T. Department is to produce a suitable report form for the use of radio traders and will also undertake to provide officers to address any meeting of radio traders anywhere in New Zealand provided due notice and an invitation to attend for that purpose is duly given.

It was revealed that the P. and T. Department have on order and will shortly land in New Zealand, equipment for the quantitative measurement of interference levels. This equipment will be available for inspection by members of the Standing Committee at any time and by delegations from Radio Traders' Associations by appointment.

The P. and T. Department have made it clear that all members of the Standing Committee will be in a very privileged position and will have the opportunity for close liaison and the investigation of any matter between meetings and without the necessity for formal procedure. All members are naturally expected to exercise a strong sense of responsibility when making calls upon the Department for investigation of a particular matter but it has been made clear that all reports from Committee members will be acted upon.

Some general notes of interest arising from the meeting were that:

(a) The State Hydro-electric Department is to consider and report upon the advisability of checking devices for radio interference as a standard procedure for approval under Electrical Wiring Regulations.

(b) The Electrical Federation suggests incorporating requirements in relationship to radio interference being incorporated in the relative New Zealand Standard Specifications.

(c) The Public Transport Association wants quantitative measurements provided in all cases of complaint and also levels considered normal for the particular case. Mr. E. H. R. Green has undertaken to provide this information and stated that in his opinion the passenger transport vehicles would provide an ideal case to commence investigation on the arrival of apparatus from overseas and in the setting up of necessary standards.

Your delegate is of the firm opinion that the following general steps are essential to any worthwhile approach to the reduction of radio interference:

(1) Active co-operation and the closest possible liaison between radio traders and the local radio inspectors combined with an active sub-committee on interference set up by the N.Z.R.T.F.

(2) The quantitative measurement of interference from all electrical devices and the setting up of mandatory standards.

(3) The publication of New Zealand Standard Specifications relating to interference-producing devices or the adoption of British Standard Specifications in so far as they apply to New Zealand conditions.

It is the intention of your delegate to press for the adoption of these principles but it must be borne in mind that considerable time may be necessary to clean up the present position which has been allowed to increase with relatively little attempt at control.

In the meantime it would be appreciated if local associations would report at least annually on pressing problems in their own district, when immediate action will be taken to investigate any worthwhile complaint. In the case of specific and isolated cases of interference, these would best be handled by an approach to the local radio inspector but in any case where such complaint fails to bring the desired result, then the local association should write a note to the secretary N.Z.R.T.F. for handing on to your delegate on the Standing Committee.—Yours etc.,

D. B. BILLING, Delegate.

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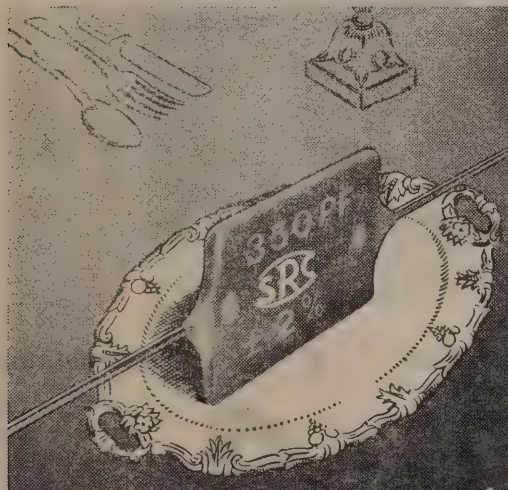

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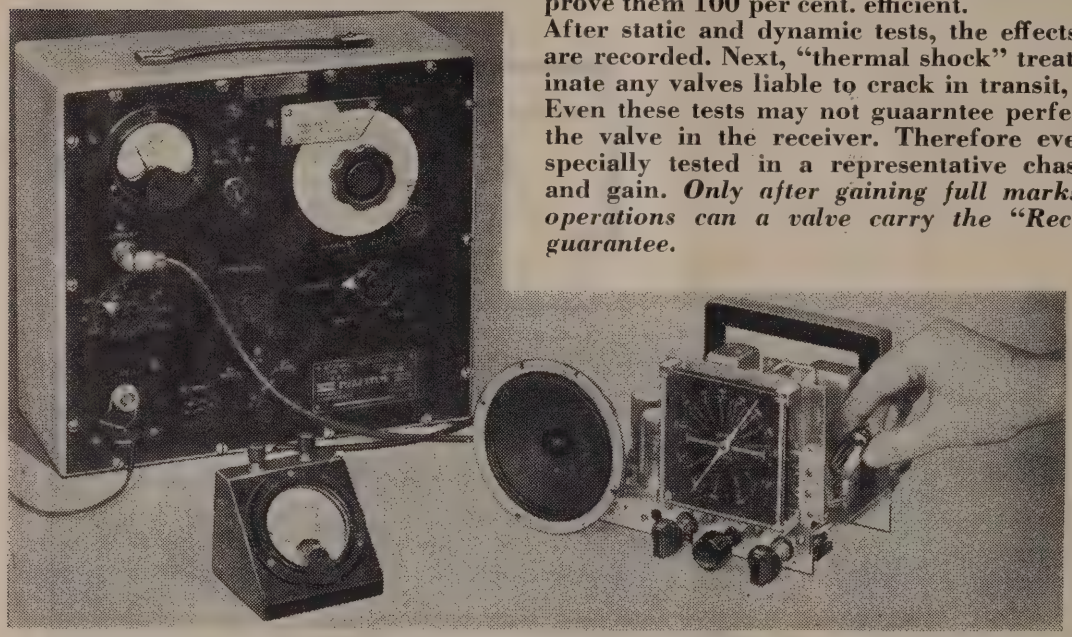

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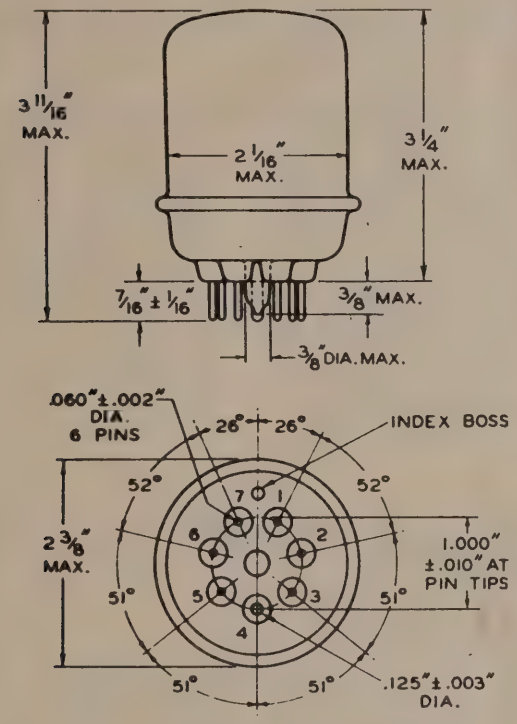
TUBE DATA: The 826 Transmitting Triode

The 826 is a three-electrode transmitting tube designed especially for use as an oscillator, R.F. power amplifier, and frequency multiplier at the ultra-high frequencies. The 826 may be operated at maximum ratings at frequencies as high as 250 megacycles and at reduced ratings at frequencies as high as 300 megacycles. Maximum plate dissipation of the 826 is 60 watts in Class C telegraph service.



BOTTOM VIEW

The double-helical thoriated-tungsten filament of the 826 is centre-tapped within the tube so that the effects of filament inductance can be minimized. In addition, short, heavy, double leads are brought out from the plate and the grid to individual terminals. This arrangement reduces the inductance of these internal connections, and permits the use of separate leads for neutralization.

All terminals are placed at one end of the bulb so that short leads can be used in neutralizing circuits.

TENTATIVE CHARACTERISTICS AND RATINGS

Filament voltage (A.C. or D.C.)	7.5	volts
Filament current	4	amps
Amplification factor	31	
Direct interelectrode capacitances:		
Grid-plate	2.9	μμf.
Grid-filament	3.7	μμf.
Plate-filament	1.4	μμf.
Bulb	T-16	
Terminal mounting	Type UT-106	
Type of cooling	Forced air	

MAXIMUM C.C.S. RATINGS AND TYPICAL OPERATING CONDITIONS

C.C.S. = Continuous Commercial Service

As R.F. Power Amplifier—Class B Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

	C.C.S.	
D.C. plate voltage	1000 max.	volts
D.C. plate current	65 max.	ma.
Plate input	65 max.	watts
Plate dissipation	60 max.	watts
Typical Operation:		
D.C. plate voltage	1000	volts
D.C. grid voltage*	—50	volts
Peak R.F. grid voltage	87	volts
D.C. plate current	65	ma.
D.C. grid current (approx.)†	8.5	ma.
Driving power (approx.)†‡	3.7	watts
Power output (approx.)	22	watts

As Grid-Modulated R.F. Power Amplifier—Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

	C.C.S.	
D.C. plate voltage	1000 max.	volts
D.C. grid voltaeg	–500 max.	volts
D.C. plate current	65 max.	ma.
Plate input	65 max.	watts
Plate dissipation	60 max.	watts
Typical Operation:		
D.C. plate voltage	1000	volts
D.C. grid voltage of	–125	volts
From a cathode resistor of	1700	ohms
Peak R.F. grid voltage	165	volts
Peak A.F. grid voltage	95	volts
D.C. plate current	65	ma.
D.C. plate current	9.5	ma.
D.C. grid current (approx.)†	9.5	ma.
Driving power (approx.)†‡	8.2	watts
Power output (approx.)	25	watts

As Plate-Modulated R.F. Power Amplifier—Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

	C.C.S.	
D.C. plate voltage	800 max.	volts
D.C. grid voltage	–500 max.	volts
D.C. plate current	95 max.	ma.
D.C. grid current	40 max.	ma.
Plate input	75 max.	watts
Plate dissipation	40 max.	watts
Typical Operation:		
D.C. plate voltage	800	volts
D.C. grid voltage*	–98	volts
From a grid resistor of	2800	ohms
Peak R.F. grid voltage	198	volts
D.C. plate current	94	ma.
D.C. grid current (approx.)†	35	ma.
Driving power (approx.)†	6.2	watts
Power output (approx.)	53	watts

As R.F. Power Amplifier and Oscillator—Class C Telegraphy

Key-down conditions per tube without modulation§

	C.C.S.	
D.C. plate voltage	1000 max.	volts
D.C. grid voltage	–500 max.	volts

D.C. plate current	125 max.	ma.
D.C. grid current	35 max.	ma.
Plate input	125 max.	watts
Plate dissipation	60 max.	watts

Typical Operation:

D.C. plate voltage	1000	volts
D.C. grid voltage*		
From a fixed supply of	–70	volts
From a grid resistor of	2000	ohms
From a cathode resistor of	440	ohms
Peak R.F. grid voltage	183	volts
D.C. plate current	125	ma.
D.C. grid current (approx.)†	35	ma.
Driving power (approx.)†	5.8	watts
Power output (approx.)	86	watts

*Grid voltages are given with respect to the mid-point of filament operated on A.C. If D.C. is used, each stated value of grid voltage should be decreased by one-half the filament voltage and the circuit returns made to the negative end of the filament.

‡At crest of audio-frequency cycle with modulation factor of 1.0.

§Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent. of the carrier conditions.

†Subject to wide variations depending on the impedance of the load circuit. High-impedance load circuits require more grid current and driving power to obtain the desired output. Low-impedance circuits need less grid current and driving power, but plate-circuit efficiency is sacrificed. The driving stage should have a tank circuit of good regulation and should be capable of delivering considerably more than the required driving power.

INSTALLATION

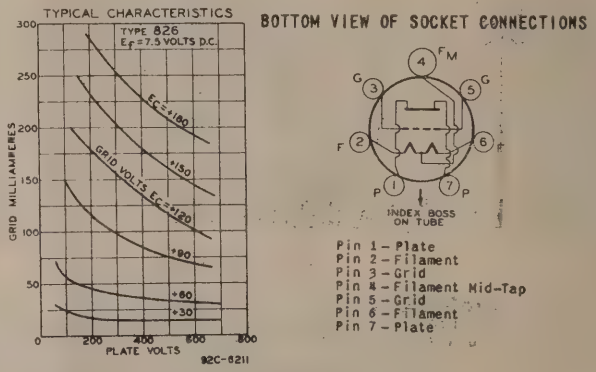
The 826 may be mounted by means of a special socket having floating contacts, such as type UT-106. Connections should never be soldered directly to the tube terminals because the heat of the soldering operation may crack the lead seals. The 826 should be mounted in a vertical position with the terminals either up or down.

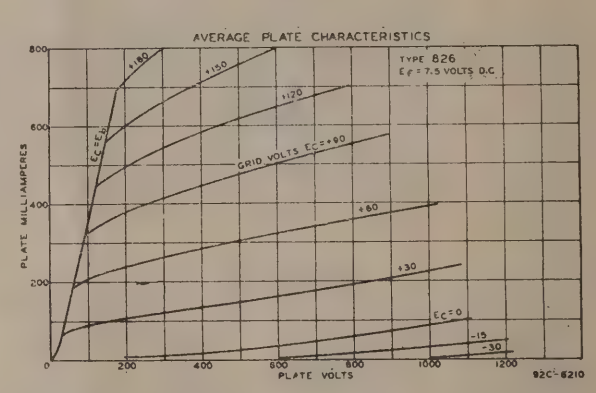
The bulb becomes very hot during continuous operation so that forced-air cooling is recommended. The installation of all wires and connections should be made so that they will not be close to or touch the bulb, in order to avoid puncture of the glass due to peak voltage effects.

The thoriated-tungsten filament of the 826 is centre-tapped within the tube. The centre lead is brought out of the bulb to a separate connection. With this design, it is possible to minimize the effects of filament-lead inductance by connecting all three leads in parallel through by-pass condensers. The centre-tap lead of this parallel connection should not be returned directly to the centre-tap of the filament-transformer winding or to ground, although it may be by-passed to either of these points if desired. The filament voltage should not vary more than ±5 per cent. from the rated value; otherwise, loss of filament emission may result. It is recommended that, in intermittent service where the average number of daily transmissions is greater than 100, the filament power during standby periods may be either removed or maintained at 80 per cent. of normal voltage, whichever is preferred. However, in applications where the average number of transmissions is usually not greater than 100 and where the standby periods are usually no longer than the transmissions periods, the filament voltage may be maintained at normal value during standby periods.

The filament of the 826 should be operated at constant voltage rather than constant current and must be allowed to reach normal operating temperature before other voltages are applied.

Overheating of the 826 by severe overload may decrease its filament emission. The filament activity can sometimes be restored by operating the filament at rated voltage for ten minutes or more without voltage on the plate and grid. This process may be accelerated by raising the filament voltage to 9 volts (not higher) for a few minutes. The positive high-voltage supply lead should be provided with a protective device, such as a relay. This device should instantly remove the plate voltage when the D.C. plate current reaches a value 50 per cent. greater than normal.





The plate of the 826 shows a dull red colour at its maximum plate-dissipation rating for each service.

R.F. by-passing of the grid- and plate-return circuits should be made to the centre lead of the filament. It is important that the returns be made to this common connection in order to avoid R.F. interaction through common return circuits. In some applications it may also be advisable to supplement this action of the by-pass condensers by R.F. chokes placed close to the condensers in the voltage-supply leads.

In order that the maximum ratings given under Characteristics will not be exceeded, changes in plate and filament voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus must be determined. An average value of plate and filament voltage should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 2000 ohms in series with the plate lead during such adjustments. *The rated plate voltage of this tube is high enough to be dangerous to the user. Care should be taken during the adjustment of circuits, especially when the exposed circuit parts are at high D.C. potential.*

APPLICATION

In class B R.F. service, the 826 may be supplied with bias from a battery, from a rectifier, or from a cathode resistor, suitably by-passed for both audio and radio frequencies.

In grid-modulated Class C telephone service, the 826 may be supplied with D.C. grid bias from a cathode resistor, unby-passed for audio frequencies, or from a fixed supply. The audio power required in this service is very small. It need be sufficient only to meet the peak power requirement of the grid of the class C amplifier on the positive crest of the input signal. The actual peak value is generally never more than 5 watts.

In plate-modulated Class C service, the 826 may be supplied with bias from a grid resistor, or from a combination of grid resistor and fixed supply, or grid resistor and cathode resistor. The cathode resistor should be suitably by-passed for both audio and radio frequencies. The combination method of grid resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias-supply compensation.

In Class C telegraph service, the 826 may be supplied with bias by any convenient method. When the 826 is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to maintain the plate current at a safe value. With

(Concluded on Page 48.)

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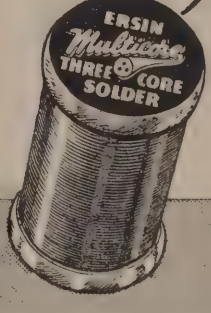

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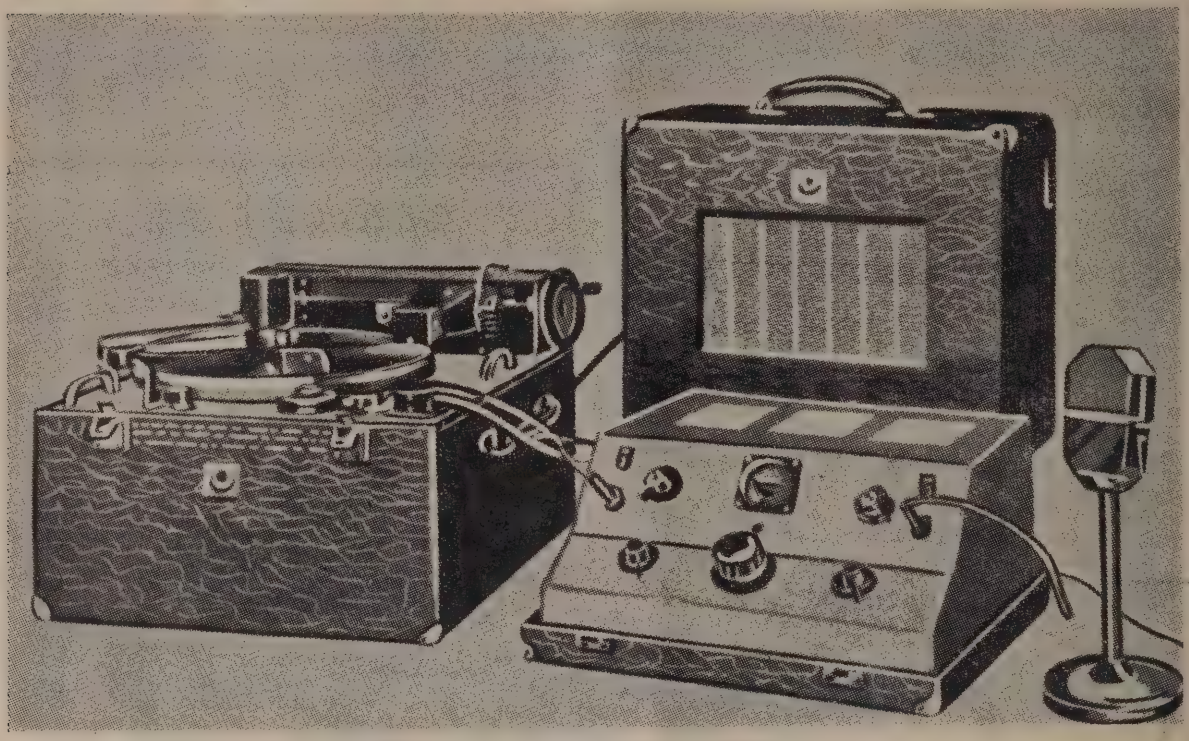

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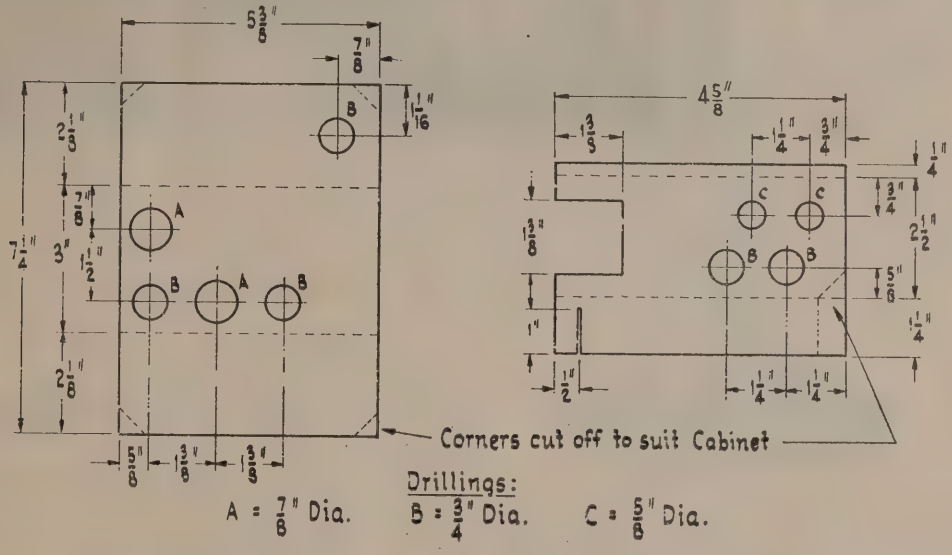
A Small 4-Valve Receiver

(Continued from Page 5.)

here its ill-effects are hardly noticeable. The first defect of simple A.V.C. is that every signal, however weak, operates the A.V.C., and reduces the sensitivity of the receiver, so that the weak-signal performance is not as good as in a set with delayed A.V.C. Here, however, the slight amount of under-biasing of the valves means that some, if not all of this loss of sensitivity is compensated for, and besides, we are not interested in sensitivities of a few microvolts in a set of this kind. The second oft-quoted disadvantage is the detector distortion introduced by the practice. In actual fact, this effect is unnoticeably small, and could never be detected in this sort of receiver, so that both the major defects of simple A.V.C. can be disposed of as far as present purposes are concerned.

Resistance-capacity smoothing has been used very successfully here, as in a number of commercial designs, and somewhat eases the space difficulty.



THE CIRCUIT

The ECH42 has been used as the oscillator-mixer, in a quite conventional circuit. The EAF42 completes the tuner section, with the pentode as the I.F. amplifier, and the diode as detector and A.V.C. rectifier combined. In the early days of superhets, it was quite common to find only one diode used in the detector-A.V.C. circuit, but this soon gave way to more complex circuits such as are common today, in which one diode of a double-diode is used as the detector, and the other as a separate A.V.C. rectifier. The main advantage to be gained by this arrangement is that the A.V.C. diode can be fed from the primary of the last I.F. transformer, where the selectivity is rather less than at the secondary. As a result, the sideband hiss that occurs with simple A.V.C. is largely avoided, and A.V.C. action is quieter. However, this is a relatively small advantage, and in a small set, where the number of parts is to be kept to a minimum, there is still a place for the simple circuit used here. The negative D.C. voltage developed by the detector diode itself is used for controlling the sensitivity, thereby saving several components. Ordinarily, this practice results in somewhat lower sensitivity than usual to weak signals, but here it has been possible to offset this to a large extent, at the same time effecting a further saving of parts. The fact that the whole set has only about 150 volts of H.T. applied to it, enables the valves to be run with zero bias. In actual practice, there is a bias of one volt or so, owing to contact potential in the detector diode, and this is effective in preventing the tubes from drawing too much current. Indeed, the consumption of the whole set when not tuned to a station is under 30 ma., and so comes within the rating of the 150v. a side, 30 ma. instrument power transformer that is used, since it is the smallest available stock commercial transformer. This elimination of cathode bypassing condensers and bias resistors results in rather higher sensitivity under weak-signal conditions than the set would otherwise have, and the performance is very good on distant stations, as well as on the locals. The output from the tuning unit is taken via a length of shielded cable from the high end of the diode load resistor. The blocking condenser is inserted at the tuner end, as shown in the diagram, and this saves hanging it on the volume control potentiometer, which would be rather awkward mechanically.

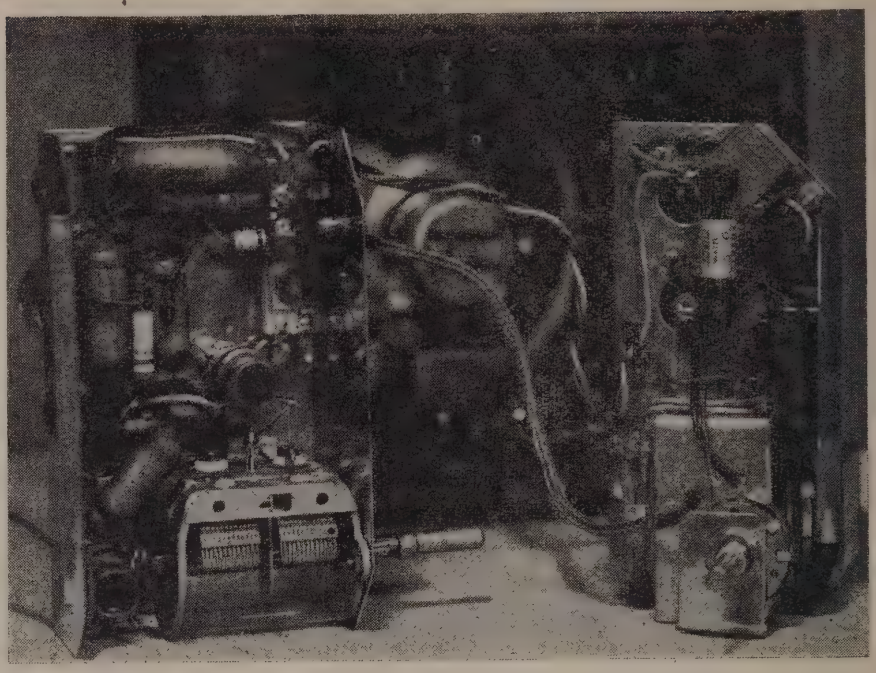
The power supply and output stage form the second unit, which is built on the power transformer. The chassis diagram shows the cut-out which enables the small chassis to be slipped over the transformer in the manner illustrated in the photographs, but does not show the small bracket on which the volume control is mounted. This bracket can be seen in the large photograph, and is mounted on the mounting lug of the transformer with a countersunk bolt. The other lug on the transformer is used to hold the unit to the cabinet, as can be seen in the back photo of the assembled set.

CONSTRUCTION

The set is built into a stock extension-speaker cabinet, made for a 5 in. speaker unit. The chassis diagrams and the photographs give a good idea of the construction, which hardly needs to be described in detail. The midget two-gang condenser is mounted under the chassis, as are the coils, so that the only parts above the chassis are the valves and the I.F. transformers. The gang used was one

with built-in trimmers, in order to save space. The oscillator coil is the one in the middle of the chassis, and der condenser. The shielded lead is the audio output, as explained above, while the unshielded cable carries the heater and H.T. supplies from the power supply unit. On the latter, best use of the available space is made by employing two small upright-mounting electrolytic condensers. The valve nearest the transformer is the rectifier.

The shaft of the tuning condenser had to be extended slightly by sweating on to it a short length of ¼in. brass rod. No reduction drive was used, the small pointer knob being attached directly on to the condenser shaft. The two escutcheons were made from a printed celluloid dial escutcheon by cutting them off the two "business" ends, and pinning them separately to the woodwork of the cabinet with ordinary small office pins. This makes a neat job that is quite professional looking. Unfortunately, the photograph hardly does justice to the small size of the set, which measures only 8 in. by 6½ in. by 4½ in. Even if builders cannot get exactly the same cabinet as we used in the original, similar ones are sure to be available and the general layout principle that this set illustrates can certainly be made use of to produce a very small set whose parts are, even so, not too crowded to make construction difficult.



View showing the chassis removed from the cabinet which can be seen in the background. Here can be seen the small bracket holding the volume control potentiometer.

Civil Aviation Expansion

As part of the programme of expanding and improving existing radio navigational aids for aviation purposes, the Civil Aviation Branch of Air Department has recently let a contract for the supply of 24 medium frequency radio beacon transmitters with Philips Electrical Industries of New Zealand Ltd. These transmitters are to be manufactured to specifications drawn up by engineers of Civil Aviation Branch.

The installation of this equipment will complete a chain of medium frequency radio beacons throughout New Zealand to be used as navigational aids for aircraft, and will be an important step towards bringing New Zealand's aeronautical radio installations up to the highest modern standards.

Mr. K. J. Horan, of the Philips Company in Adelaide, where the equipment will be manufactured, recently arrived by air to discuss technical details with the design engineers of the Civil Aviation Branch Radio Engineering Section.

RADIO Text-books for sale—Ultra High Frequency Techniques, 40/-; Servicing by Signal Tracing, Rider, 18/6; Radio Physics Course, Chiradi, 22/6; Modern Radio Servicing, Chiradi, 29/6; Radio Troubleshooters' Handbook, Chiradi, 31/6.—Graham Goodger, 76E Rongotai Terrace, Wellington, E.3.

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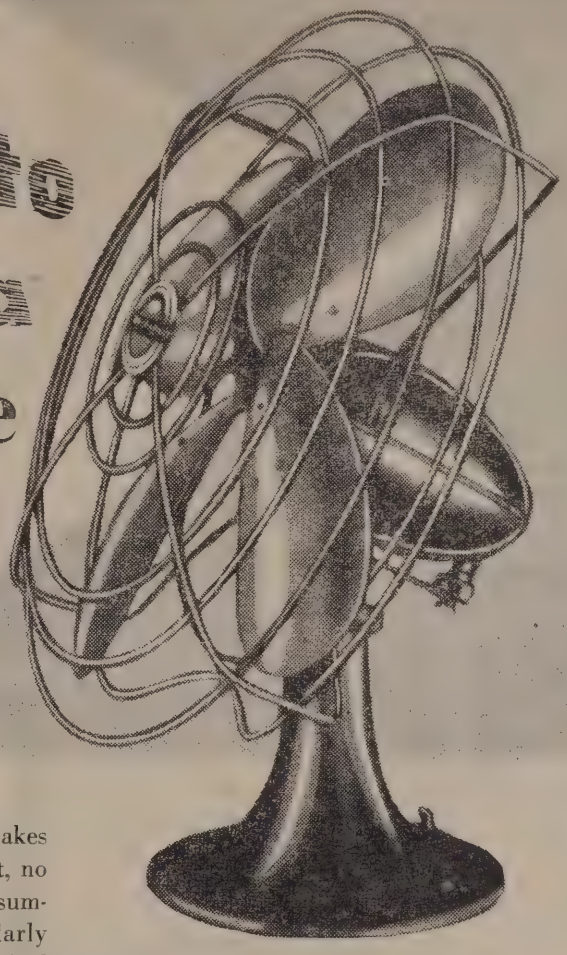

8" AND 10" DESK FANS

This model is moderately priced and makes an ideal gift to friends or family. In fact, no family should be without one during the summer months. It is sturdily built, particularly silent in operation, and attractively finished in iridescent blue.

10" AND 12" OSCILLATING AND 12" FIXED FANS

These popular models in either ivory or iridescent blue are equally suitable for home or office use. The oscillating models have an 80° arc of oscillation and can be converted to fixed fans by a slight adjustment.

16" OSCILLATING FAN

The ideal fan for installing in large offices or rooms, and designed for either mantelpiece or wall mounting. It is silent in operation, efficient in cooling, and will displace nearly 2,000 cubic feet of air per minute. Modern in appearance, and attractively finished in iridescent blue. with a well ventilated motor that runs continuously without overheating.

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THE "RADIO AND ELECTRONICS" ABSTRACT SERVICE

ANTENNAE AND TRANSMISSION LINES

Microwave rotating joints—Part II. The form described consists of a rectangular waveguide-to-concentric-line transformer, followed by a length of concentric line and completed by a second transition.

—*Electronic Engineering* (Eng.), Oct., 1951, p. 377.

A difficult problem has been the installation of antennae systems in hotels and public buildings. An outline of master antenna systems whereby all receivers are fed through suitable distribution boxes from a high-gain system, is the practical solution.

—*Service* (U.S.A.), August, 1951, p. 18.

AUDIO EQUIPMENT AND DESIGN

A portable tone source deevloped for use in room acoustics. Use is made of an audio frequency tone warbled to average the reverberation time over a band of frequencies and it is desirable that the bandwidth should be a fixed percentage of the mean frequency. An instrument is discussed to effect this purpose.

—*Electronic Engineering* (Eng.), October, 1951, p. 368.

Repair that speaker! A bottle of cement and thinner is all that is required for repairing that rubbing voice coil. Detailed instructions given.

—*Radio and Television News* (U.S.A.), September, 1951, p. 39.

The first of a series of articles on the various problems which must be considered when designing or setting up any reproducing system. These should assist the assimilation of all the scattered information now available.

—*Radio and Television News* (U.S.A.), September, 1951, p. 48.

There is no substitute for a horn for true sound production, but there are practical limitations on its size. Here is one for tucking into the corner and its design is unusual. Linoleum and plywood are the only materials required.

—*Radio and Television News* (U.S.A.), September, 1951, p. 62.

The application of damping to phone arms—audio definitions—pre-amplifier designs—portable tape recording features. The article emphasizes that the arm and its components contribute a key factor in playback operation.

—*Service* (U.S.A.), August, 1951, p. 30.

CIRCUITS AND CIRCUIT ELEMENTS

Voltage regulators. Experimenters often require power supplies with varying voltages and having made one find that the regulation is very poor. Useful ideas on regulation provided and the valves required.

—*Radio and Television News* (U.S.A.), September, 1951, p. 69.

Resistance-capacity tone control are used almost universally because of their many advantages over L.C.R. networks, but many leave much to be desired. People like "boost" type control and the circuit presented meets this requirement to an unusual degree.

ELECTRONIC DEVICES

Electronic control systems for D.C. motors consist basically of a grid controlled rectifier to supply power to the armature, a smaller rectifier to supply field excitation and a control circuit. The article deals with methods of controlling thyratrons, speed control and complete motor control.

—*Electronic Application Bulletin* (Holland), Jan. 1951, p. 18.

The Hammond Organ, notes on the history and manufacture of the tone generator—principles of generation—blending of the harmonics—keys and stops, vibrato, and artificial reverberation.

—*Electronic Engineering* (Eng.), October, 1951, p. 382.

More light on the constructions of radio control for model aeroplanes. Whereas the escapement principle works well, some have asked for more precision and the new actuator which works on a different principle provides this. A pulsed transmitter is used.

— *Radio and Television News* (U.S.A.), September, 1951, p. 59.

INSTRUMENTS AND TEST GEAR

An oscillator whose frequency can be automatically swept over a given band has many important applications, for instance alignment of tuned R.F. amplifiers. There is described a model which can be made to operate up to approximately 180 mc/sec. with bandwidth in excess of one octave.

—*Wireless Engineer* (Eng.), September, 1951, p. 266.

Field strength meters of the crystal diode type fall down in that they are not logarithmic or sufficiently sensitive. The meter described approaches the first and will give usable readings several thousand feet from a low powered beam.

—*QST* (U.S.A.), January, 1951, p. 24.

A wide test oscillator—50 c.p.s. to 500 kc/sec. in one simple compact unit; 6AG7 amplifier coupled to 6AG7 cathode follower. Two feedback loops are provided and oscillation occurs at the null frequency of the bridge.

—*Ibid*, p. 29.

A problem in making a successful "Q" meter is constructing and calibrating the resistor used for injecting the known E.M.F. to the resonant circuit and making a stable voltmeter for measuring resonant voltage. These objections are overcome and the meter may be made from surplus components.

Electronic Engineering (Eng.), October, 1951, p. 374.

The problem of matching a load to a source and the subsequent measurement of power transfer is not simple at high frequencies. A meter is described which will indicate forward and reflected power simultaneously.

—*Wireless Engineer* (Eng.), September, 1951, p. 279.

MATERIALS, VALVES, AND SUBSIDIARY TECHNIQUES

General Electric has demonstrated a receiver using five germanium crystal diodes in the R.F., detector, and push-pull A.F. output. The triode is described in detail.

—*Electronic Engineering* (Eng.), October, 1951, p. 393.

For audio frequency transformers it is necessary to know more about the characteristics of iron losses in the core, and a method of analysis is necessary. Very full charts given for this purpose.

—*Ibid*, p. 396.

Shortages of copper and cobalt in the U.S.A. have made electrostatic focused tubes more popular. High voltages are required and special transformers are designed for use with these tubes.

—*Radio and Television News* (U.S..), September, 1951, p. 51.

PROPAGATION

Results of measurements of the delay of the first ionoscopic echo after the ground ray over long distances described. It is shown that there are three subsidiary reflecting regions at heights of 120-130 km., 105-110 km., and 70-76 km. effective under certain conditions. Work was done at 2 mc/sec on Loran system.

—*Wireless Engineer* (Eng.), September, 1951, p. 271.

RECEIVERS

Amateurs have never quite decided what they want in the way of high-class receivers. A few block diagrams of some amateur types are given showing a wide diversity of features of advanced design.

—*QST* (U.S.A.), January, p. 17.

TELEVISION

The construction of a simple display unit for the visual examination of television waveform described. It selects any desired set from 1 to 20 lines of both frames for separate and simultaneous display. The apparatus is convenient for investigating defects in interlacing.
—*Wireless Engineer* (Eng.), September, 1951, p. 261.

A study of video amplifiers, forms of controls of various types and the trends of modern practice.
—*Television Engineering* (U.S.A.), August, 1951, p. 10.

Television has found the need for a type of lighting more suitable to its requirements; recently processed light with improved spectral characteristics has been developed and blue reflectors to provide colour balance and harmony developed.
—*Ibid*, p. 16.

Automatic synchronism generator for TV. The equipment features binary scale counters to supply 525-1 and 2-1 divisions and also gates for sync. signal generation.
—*Ibid*, p. 20.

Methods of converting a monochrome to colour CBS—conversion procedure with the colour wheel—examples of electrostatic conversions and the circuitry.
—*Service* (U.S.A.), August, 1951, p. 21.

Boosters or pre-amplifiers have completely shed their doubtful status and proved themselves extremely useful and reliable in TV fields. A one-tube unit installed in TV chasses can be used to provide an additional I.F. stage to video or sound systems.
—*Ibid*, p. 22.

Servicing helps for the TV technician. The article deals with the diagnosis and fixing of troubles in receivers.
—*Ibid*, p. 44.

TRANSMITTERS AND TRANSMITTING

Bandpass coupling between the transmitter stages is coming into greater prominence on account of TVI. The transmitter described is a single control type, 35-40 watt input, 80, 40, 20, and 10 metre bands.
—*QST* (U.S.A.), January, 1951, p. 11.

MISCELLANEOUS

Growing needs of science and technology for intense sources of high energy particles and other forms of ionizing energy are being met to an increased extent by devices which depend on electrostatic forces and principles. Their effectivness is paramount for nuclear research, supervoltage X-rays, treatment and sterilization of biologicals, etc.
—*Electrical Engineering* (U.S.A.), September, 1951, p. 781.

To operate a fluorescent lamp it has to be connected in series with a certain impedance, but an incandescent lamp can be used. This offers some solution to the starting problems and a special lamp has been designed for the job.
—*Philips Technical Review* (Holland), Vol. 12, No. 5, p. 129.

1952 CLASSES

For Marine Radio Operators, Broadcast Technicians, and Radio Servicemen commence 4th February.

Apply now for Free Prospectus

NEW ZEALAND RADIO COLLEGE

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KNOWN FOR RELIABILITY IN FORTY COUNTRIES . . .

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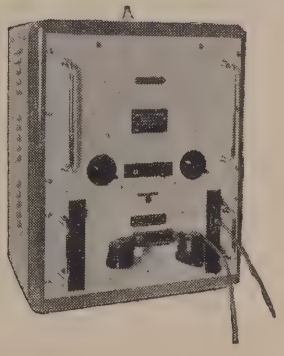

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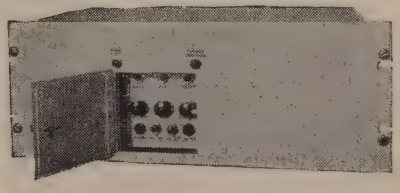
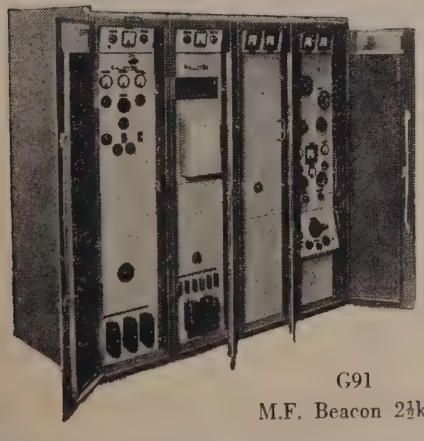


R93
HF Fixed Frequency Receiver



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Television and Wired-sound Relaying Systems
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Frequency Shift Keyers Antenna Amplifiers
Receivers for any band, 13 kc. to 132 mc/s.

REDIFON REPRESENTATIVES:

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INQUIRIES SOLICITED

Missing or Stolen Radios

The Police Department has supplied the New Zealand Radio Traders' Federation with the following list of missing or stolen radio sets. Should any member of the Federation or other reader have any knowledge of the present whereabouts of any of this radio equipment, he is asked to communicate with the nearest police station.

Police Station, Thames:

On 14th September, 1951, a radio set was brought from Coromandel to Thames by bus. On the freight being discharged from the bus this radio was left on the footpath and it went missing from there.

Description: "Columbus" vibrator model, battery, No. 19072, Warrior cabinet No. 705, valued at £50. Property of Kenneth Jim McNab, Papa Aroha R.D., Coromandel.

Police Station, Taihape:

In accordance with instructions received I am forwarding particulars of a stolen radio:

Kevin Patrick O'Brien, timber worker, of Waiouru Camp, reported to the police that on 28th September, 1951, a radio set and other property was stolen from his bedroom at the camp.

Description: Cromwell or Gulbransen make. White plastic case about 15 in. by 6 in. in size. Five-valve electric, "Little Jewel" style. Serial No. S/N 77070.

Local inquiries have failed to trace the missing property to date.

Police Station, Dunedin:

I have to advise that the following described radio was stolen from a consignment of radios forwarded from Messrs. Russell Imports Ltd., Christchurch, on 27th September, 1951, to Messrs. Calder Mackay, Ltd., Dunedin:

Description: One Philco portable radio, model No. 353, 6-valve broadcast, battery-electric, four control knobs, brown colour with brown mottled colour leatherette ends, wooden front-piece, with wooden roll-top. Effect piece over dial, leather carrying strap across top. Serial No. 30238, valued at £36.

Police Station, Wellington:

I have to advise you that it has been reported to this Department that during the months of July and August, 1951, four motor-car radios were stolen from the premises of Messrs. Todd Motors, Ltd., Courtenay Place, Wellington.

The four radios are all of "Aristocrat" trade make, made by Messrs. Philips Electrical Industries of New Zealand, Ltd., Wellington Motor-car radios:

1. No. 5343
2. No. 5388.
3. No. 5488.
4. No. 5452.

All of the radios are in new condition and valued at £36 15s. each.

Criminal Investigation Branch, Christchurch:

Stolen from Elco Rubber Company, Ltd., Hornby, on 21/11/51 or 22/11/51.

Description: "Rolls" 5-valve broadcast radio, cabinet of polished walnut coloured wood, three knobs fitted to dial, size approximately 18 in. x 10 in. x 8 in. Serial No. 136486.

Police Station, Otorohanga:

Stolen from the Otorohanga District High School Dental Clinic on the night of 17/10/51, the property of Patricia Thela Foreman.

Description: One gold and brown coloured portable "Cromwell" with plug-in attachment, base 6 in. square, height, 12 in., valued at £20, not identifiable. No further description is available.

Police Station, Lower Hutt:

Stolen from American quarters at Mangaroa end of Rimutaka tunnel on or about 18/11/51.

Description: Zenith Trans-Oceanic long-distance standard short-wave portable radio. Model 8.G.005—Y.T.Z.I. Serial number J.62922. Built-in extension aerial telescoping into cabinet. Hinged cabinet top. Valued at about £80 in New Zealand.

Police Station, Putaruru:

Stolen from Putaruru on the 25th September, 1951.

Description: Philips portable, Model 545, radio stolen. Serial No. 1046-3608. Valued at £20.

Criminal Investigation Branch, Christchurch:

Stolen at Christchurch 3/11/51.

Description: Ultimate "Gypsy" model, battery portable radio. Mottled brown and fawn colour. Ivory plastic dial and handle. Model R.A.N. Serial No. 121768 on chassis. Distinguishing features—it has not the usual name Ultimate on the lower right corner of the cabinet. It was fitted with a light socket plug. Valued at £36.

Police Station Timaru:

Stolen from the Radio Department of the Canterbury Farmers' Co-operative Association between 9th and 12th November, 1951.

Description: Tuner section of Pacemaker auto radio, brown crinkled finish, oblong dial, two brown composition knobs, new. Serial No. 95918.

N.Z. Police, District Office, Dunedin:

Radio set alleged stolen from consignment forwarded from Messrs. Russell Imports Ltd., Christchurch, on 27th September, 1951, to Messrs. Calder Mackay, Ltd., Dunedin.

In reference to the above, it is advised that the Philco portable radio set has now been recovered intact.

ANNOUNCEMENT!

SWAN ELECTRIC CO. LTD. MOVES

Into New Premises in Wellington

On the 11th January, Swan Electric Co. Ltd., will move its branch from Hope Gibbons Building, Dixon Street, to Hood's Building, 177 Thorndon Quay. They have been fortunate to obtain these new and spacious premises, which will have no equal in the radio and electrical wholesale trade.

Postal address is now C.P.O. Box 1710

Telephone 46-917

Leading Radio Trader Retires

MR. ALFRED WYNESS

At the Royal Oak Hotel, Wellington, on Wednesday, 5th December, 1951, a large gathering of friends and business associates met to bid farewell and good wishes to Mr. Alfred Wyness, of H.M.V.(N.Z.) Ltd., on his relinquishing the Managing Directorship in favour of his son, Jack Wyness.

From small beginnings some 40 years ago, Mr. A. Wyness has built up one of the most prosperous and efficient businesses in the radio industry, and the time has come when, for health reasons, he proposes to take business life somewhat easier. He will continue to act as Chairman of Directors of H.M.V.(N.Z.) Ltd. This journal takes pleasure in paying tribute to Mr. A. Wyness for the esteem in which he is held throughout the industry and wishes him many years of happy semi-retirement.

Many speeches representative of the gramophone and radio industries and of personal relations with Mr. A. Wyness showed the high esteem in which he is held throughout all spheres of life.

Mr. E. J. Hyams, of E. J. Hyams & Son, Ltd., spoke of his early association with Mr. Wyness, when they were interested in marketing gramophones and record-

Mr. A. Wyness

ings some 40 years ago. A cordial and unbroken friendship had existed ever since and it showed sound business ability when it was realized that from this small indent business Mr. Wyness had established one of the largest manufacturing industries of its kind in New Zealand.

Mr. Len Southward, whose interest in things mechanical is well known, produced, with the aid of Mr. Jim McGregor, a "live" model of H.M.V. horn type gramophone mounted with "Little Nipper." This was formally handed over to Mr. Jack Wyness, who now carries the responsibility of Managing Directorship of H.M.V. (N.Z.), Ltd., and all that this famous trade-mark stands for.

Mr. J. Sutcliffe, radio dealer of Hastings, said he represented about 25 radio dealers who had years of pleasant associations with Mr. A. Wyness, and he recalled the fateful days of 1931, when the Napier earthquake took such a heavy toll of the radio industry there, and how Mr. Wyness with untiring energy, helped so much to rehabilitate dealers. He extended good wishes to Mr. and Mrs. Wyness and offered congratulations oin his promotion to Mr. Jack Wyness with whom he had been associated in business for many years including a visit to the H.M.V. organization at Hayes, Middlesex.

Many tributes were read by Mr. R. Bull, Secretary of the Company, including those from the parent Company, and Sir Ernest Fisk. A letter from Mr. Ralph Slade, who was unavoidably absent, conveyed tribute from the Radio and Television Manufacturers' Federation. This was supported by remarks from Mr. P. C. Collier, who said that for 20 years he had known Mr. Wyness and admired his business ethics and ever ready pleasant approaches.

The Hon. Rbt. McKeen, who is a neighbour, added his tribute, saying that even as a politician he could claim to a personal knowledge and understanding of so fine a business man as Mr. Wyness. It had been his pleasure to exchange reminiscences with him, and he had gained experience invaluable from this contact of friendship. Both Mr. and Mrs. Wyness had come from humble townships in Scotland, and the upbringing in that rugged country had served them both well in the later hard school of experience. Both were kindly and lovable people ready at all times to help others and he wished them a successful and happy retirement.

Mr. Murray Wiseman, of Auckland, on behalf of Mis Master's Voice dealers throughout New Zealand, presented Mr. Wyness with a handsome writing bureau, and to Mrs. Wyness an afternoon tea trolly and some handsome china. He spoke of the appreciation of Mr. Wyness's services, by the H.M.V. dealers. This presentation was accompanied by musical honours.

On behalf of the senior executives and staff of H.M.V. (N.Z.) Ltd., Mr. R. Bull presented Mr. Wyness with a bedroom clock, remarking that in the leisure time which he would have in the future the alarm could be ignored with impunity.

A musical item was given by Miss Jean Calder and Mr. Len Wilson (the Otago Rambler).

From the company present, Mr. Stewart Duff handed over an autographed "Appreciation" containing signatures of those present.

In reply, Mr. Wyness, obviously much overwhelmed with the many tributes extended to him, thanked all for their presence and the tokens of goodwill to himself and his wife. He was very honoured to have so many friends present and would ever remember his long and pleasant associations in the gramophone and radio business. He specially wanted to say that there was not a shop in the trade into which he could not go and feel at home. He had affection for H.M.V. and its association with the famous dog, and if he had somewhat made this dog bark, he also felt that his successor, his own son, could be relied upon to make it bark even harder. Such success as he had achieved was in a large measure due to having a loyal staff and to the fact that he had early acquired certain Christian principles which he had tried to put into practice.

Mr. Jack Wyness said that he had accepted a big responsibility but felt that with the ensured co-operation of the staff with which he was proud to be associated, the name of H.M.V. (N.Z.) Ltd. would be carried on with honour to the founder in New Zealand.

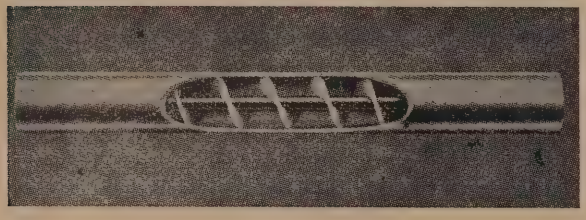
(Concluded on Page. 47.)

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. Advertising rates are charged according to space occupied. For further particulars contact Advertising Manager, R. and E., Box 8022, Wellington.

R.F. CABLE—A NEW DEVELOPMENT BY TELCON

Helical Membrane Cables



The Helical Membrane cable was developed primarily for radio-frequency applications to provide a highly efficient construction which would not have the same frequency limitations as disk-spaced cables. The insulation is comprised of a thin polythene tape lapped edge-on around the inner conductor. A practical method of achieving this basic form of the insulation has been sought unsuccessfully for many years, but Telcon have succeeded in overcoming the difficulties involved. In the practical form which has been realized, the effective permittivity is as low as that of any commercial form of disk spaced cable and preliminary tests indicate that an extremely high degree of uniformity has been achieved. In combination with an aluminium sheath as an outer conductor and as a watertight covering, it has electrical characteristics closely approaching the optimum and yet is mechanically extremely robust and reliable.

Manufactured by Telegraph Construction and Maintenance Co., Ltd., London, England. New Zealand Associates, Amalgamated Wireless A/sia, Ltd., C.P.O. Box 830, Wellington.

* * *

NEW TOOL FOR THE WORKSHOP

A handy tool which recently came to our notice and which was tried out in our laboratory, is the Niblex cutter. Radio servicemen who have not seen this tool will be interested in our comments given below.

The Nibblex cutter tool is a clever machine designed to overcome a long-standing need in the workshop. Its ability to cut through a large sheet of metal and even cut shapes, provided they don't involve sharp turns, or too small a circle, is extremely useful. The Nibblex cutter is gloriously simple and consists of a shaft with an eccentric cam on it which in turn drives a small circular punch of about 5/32 in. diameter. The whole arrangement is encased in a neat little cast container with only the punch dies and motor shaft protruding. When the shaft is driven the die punches out a small half-moon of metal from the sheet to be cut and as the die is working quite fast it literally punches its way through.

For best results it appears to need mounting on some sort of carrier assembly which the handyman can contrive to make. This carrier should be arranged to operate the cutter in a drill press so that the motor shaft is held in the drill chuck and the Nibblex prevented from turning by clamping the carrier to the tubular upright of the drill press.

This set up leaves both hands free to manoeuvre the work and will be found most satisfactory. The Nibblex cutter comes in two sizes—one for use on metal up to 19 gauge and the larger model for use on quite heavy metal.

* * *

NEW MARKING AND BINDING TOOL KIT

In the July, 1951, issue (inside front cover) was featured the Hellerman marking and binding system for insulating and identifying cables by means of special quality elastic sleeves filled under tension. It described a range of sleeves and spreading tools suitable for all purposes, particularly manufacturers and large industrial users.

The arrival of a small, versatile, yet cheap, kit suitable for smaller users, such as radio dealers, servicemen, and electricians, is now announced. This kit which retails at 42s. 6d. (from which price there are the usual trade discounts) comprises—

1 Type T L Tool

1 Bottle Hellerine Lubricant

An assortment of genuine rubber sleeves in red and black

Hellerman cable markers printed "Earth."

The initial shipment is, unfortunately, a small one and inquiries should be sent without delay for this very useful kit to the New Zealand distributors, Swan Electric Co., Ltd.

PUBLICATIONS RECEIVED

The Scanner, May, June, 1951. Decca Radar Ltd., England. (Electronic Navigation, Ltd.)

Rediffusion Bulletins Nos. 26 and 27. Rediffusion Ltd., England. (Collier and Beale, Ltd.)

Das Electron—Technischer Verlag, Austria.

Dial, No. 2, Vol. 8. International General Electric Co., Inc., Ltd. (National Electrical and Engineering Co., Ltd.)

Catalogue: 1951—Muirhead and Co., Ltd., England (Richardson McCabe and Co., Ltd.)

Catalogue: Cables for Radio Frequencies, Telegraph Construction and Maintenance Co., Ltd. (A.W.A. Ltd.)

Stock Record: November, 1951. Cory-Wright and Salmon Ltd.

"GE." Photo Accessory Catalogue. General Electric Co., U.S.A. (National Electrical and Engineering Co., Ltd.)

BACK NUMBERS OF "R. & E."

Back numbers are available from:—

Te Aro Book Depot, Courtenay Pl., Wellington.
S.O.S. Radio, Ltd., 283 Queen Street, Auckland.
S.O.S. Radio, Ltd., 1 Ward Street, Hamilton.
Tricity House, 209 Manchester Street, Christchurch.
Ken's Newsagency, 133–135 Stuart Street, Dunedin.
Webb's Radios, Ltd., 11 Wellesley St. E., Auckland.

TRADE WINDS

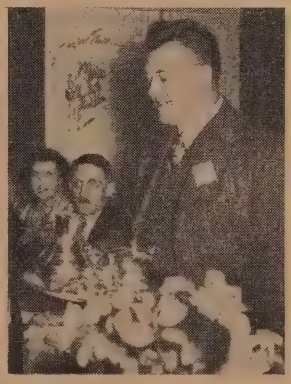
TWENTY-FIVE YEARS OF RADIO MANUFACTURE

COLLIER AND BEALE, LTD., CELEBRATE THEIR SILVER JUBILEE

If there are one or two firms which can be singled out as having played an outstanding part in the establishment and development of the radio manufacturing industry in New Zealand, one of those firms is the company founded in 1926 by Messrs. P. C. Collier and G. H. Beale. This journal was privileged to be present at a dinner given on 7th December by the directors of Collier and Beale, Ltd., in order to celebrate the 25th anniversary of the company's foundation, and it is with considerable pleasure that we have to report this very pleasant function.

The dinner took place at the Roseland Cabaret, Wellington, which was specially decorated for the occasion, both with the conventional streamers, balloons, etc., and by a special lighting display devised and executed, we believe, by the company's design engineer, at the cost of much midnight oil and several grey hairs. At every place was an envelope containing a beautifully illustrated souvenir brochure, containing a brief history of the firm, and illustrating the many phases of the firm's activity.

Proceedings opened with the loyal toast, which was followed by the assembled company's standing in silent



Left to right: (1) Mr. H. B. Grove, master of ceremonies. (2) Mr. W. Clarke making a presentation to Mr. P. C. Collier. (3) Mr. G. H. Beale replying after the presentation. (4) Mr. W. Clarke.

respect to those former colleagues who gave their lives in the late world war. Mr. P. C. Collier, Managing Director of the company, then welcomed the guests, and pointed out that the dinner was being given by the directors of the company not as a means of expressing self-congratulation, but in order to do honour of their staff—a large body of men and women who had given such loyal and willing service to the company, and without whose assistance the prosperity and success of the company would not have been possible. The hundred and twenty odd people present then proceeded to do full justice to a dinner that was more than worthy of the occasion.

We have not made it clear, perhaps, that the occasion was purely a domestic one, at which the directors entertained the whole of their large staff. The only "outsiders" present were several people who have been closely associated with the firm since its inception, and who, by virtue of long and intimate associations could almost be said to belong to the company.

The dinner disposed of, Mr. H. B. Grove, the company's oldest employee, acted as master of ceremonies during the ensuing programme of speeches and presentations. To start the ball rolling, Messrs. J. S. Burns, representing the head office staff, and A. G. Dick, representing the factory staff, made short speeches congratulating the founders on their success over the past twenty-five years, and assuring them of the high esteem in which they are held by all who belong to the large and growing family that is Collier and Beale, Ltd. Mr. Grove then amplified the sentiments expressed by these two speakers, and presented Mr. Collier and Mr. Beale each with a magnificent silver tea service, on behalf of the whole staff, as a tangible token of their esteem and goodwill.

In replying to Mr. Grove, Mr. Collier said that he was most deeply apreciative of the honour done to him by the staff in making him such a wonderful presentation, and went on to pay tributes to the many members who had worked with the firm for long periods. Mr. Collier traced the development of the firm from the time when he and Mr. Beale opened the doors of their first premises in Farish Street. A major point of policy, even in those first days, was that of providing well-equipped workshop facilities, and Mr. Collier recalled that of the first modest capital with which the firm was formed, more than a half was spent on machine tools. That policy of sound mechanical engineering, allied to electronic circuitry, had proved itself to be the right one, and in this portion of the work of the company, Mr. Collier made special mention of the sterling work of Mr. Grove, head of the engineering production department. Mr. Grove, he said, was the oldest staff member, having joined the company only a few months after its inception, and was an outstanding mechanical engineer. No job was too difficult for him, and Mr. Collier well remembered the first die that Mr. Grove had made. It did an excellent job, he said, and should be a treasured museum piece today.

Mr. Collier paid special tribute to his co-founder, Mr. G. H. Beale. Mr. Beale and he had never had a

cross word during the whole of their long association, in spite of their obviously different temperaments, and Mr. Collier considered himself to have been the most fortunate of men to have as his main business associate one whom he had always held in the highest possible regard. Mr. Collier went on to say how much, too, he valued the association with the firm of Mr. R. Bloxam, the company's secretary, and now also a director. Routine work had always been something of a headache to himself, Mr. Collier remarked, and Mr. Bloxam's association with the firm dated from the time when it first became apparent that someone would be needed to take care of the bookwork, and other jobs that came under the heading of necessary "chores" to him.

Mr. Beale, in his reply, paid a tribute to Mr. Collier, saying that it was his (Mr. Collier's) foresight in predicting a future for radio in this country that had been the mainspring of the company's activities, and that the gathering that night was due, as much as anything, to Mr. Collier's sound ideas, which had borne much fruit. Mr. Collier was quite right, he said, in remarking on the harmonious co-operation that had always existed between them as business partners, and he was proud to have been associated with Mr. Collier, and with so many other members of the Collier and Beale family for so long. In concluding his remarks, Mr. Beale said that he saw no reason why the company should not be holding a similar, but very much larger function of the same kind, twenty-five years from now.

Both founders were given a warm ovation at the conclusion of their speeches, such as left no doubt of the affection and esteem in which they are held by the staff members.

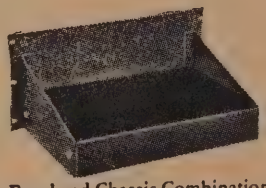
Mr. Bloxam, who as a director of the firm, was also presented by the staff with a silver tea service, also replied in suitable terms, whereupon the toasts of the Directors and the Staff were drunk, with musical honours on both sides.

Speeches were also made by Mr. F. Thomas and Mr. W. Clarke. Mr. Thomas, who, he said, knew the firm of Collier and Beale before it existed, gave many amusing reminiscences of the very early days when Mr. Collier, with his own hands, made him his first radio set—and it worked—just as do the firm's later more streamlined products.

Mr. W. Clarke, on behalf of H. W. Clarke and Co., Ltd., spoke of the cordial relationship which had always existed between his firm and Collier and Beale, Ltd. It spoke volumes for their business ethics that there had never been any formal written agreement between the two firms, in spite of the very large volumes of business that had been transacted over the years. On behalf of his company's directors, Mr. Clarke presented Mr. Collier and Mr. Beale each with a pair of binoculars, with an engraved silver mounting on the case. To Mrs. Collier and Mrs. Beale, he also presented several beautiful pieces of crystal.

After the programme of speeches was over, tables were cleared away and the evening continued with games, dancing, and community singing until a late hour. It was apparent that everyone was thoroughly enjoying himself, and the consensus of opinion seemed to be that the directors would be warmly applauded if they could think of an excuse for a similar show every year!

★CHASSIS ★CABINETS ★RACKS



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15in. x 9in. x 3in., 20/–	16in. x 9in., 17/6	9in., 8/–
12in. x 8in. x 2½in., 18/6	13in. x 8in., 15/–	8in., 7/6
9in. x 7in. x 2½in., 15/–	10in. x 7in., 12/–	7in., 7/–

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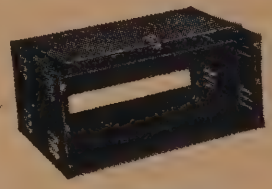
9in. x 7in. x 2½in.	£3 5 0	£3 0 0



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Head of Philips Visits New Zealand

In the December issue of this journal readers will remember that there appeared an obituary notice reporting the death at the age of 77 of Dr. A. F. Philips, co-founder and head of the great Philips organization. Early last month, just as our December issue came from the press, we had the pleasure of being present at a press conference held by Mr. Frits F. Philips, Dr. Philips's son, who was in New Zealand for a short time during the course of a world tour.

Mr. Philips, who has succeded his father as head of the world-wide Philips organization, impressed everyone at once by his friendliness, his willingness to talk, and by the breadth of his outlook, not only in matters affecting his firm, but with regard to world problems and conditions. Needless to say, of greatest interest were his remarks and replies to questions concerning his own firm and its products. For example, his ideas on the carrying out of research work by large commercial organizations were most illuminating, and one felt that an hour's talk from him on that subject alone would have been well worth reporting verbatim. Those who are fortunate enough to receive copies of the many Philips technical publications obtain some inkling of the vast amount of work, on an amazing variety of subjects that is carried out in the research laboratories at Eindhoven, but the full implications of that work are seldom realized. Mr. Philips said, in answer to a question, that large "pure" research projects were put in train at Eindhoven, and as often as not, these returned handsome commercial dividends. He instanced the case of an investigation that was instituted into certain radiation phenomena—in the X-ray field—resulted in the discovery of a new vitamin preparation which was actually put into production. This seems rather a far cry from plain electricity, but illustrates what can be done, Mr. Philips remarked, when a team of pure scientists is associated with and backed up by men with remarkable foresight for commercial possibilities. The Philips application engineers, said Mr. Philips, were able to "smell" commercial possibilities, almost literally!

Another interesting fact that could hardly by suspected by anyone outside the organization, is that the firm of Philips has an internal policy of turning out only those products that are difficult to design and manufacture. Only by so doing, Mr. Philips pointed out, can the best use be made of extensive research facilities. Nor is the organization interested in the commercial application of its products. For example, while Philips has carried out very extensive development work on special equipment for television, this has been done only with a view to manufacturing and selling TV equipment, and not with the idea of entering the field of TV broadcasting, which properly belongs not to those who make the equipment, but to others possessing the experience which is necessary on the programming and production side of TV. Mr. Philips made this reply to a question asking whether Philips would be interested in instituting TV broadcasts in New Zealand, should the Government allow private enterprise to provide TV services.

Mr. Philips was particularly interesting on the subject of television, which, of course, was the chief subject upon which the representatives of the daily press wanted him to discourse. Having had first-hand experience, by virtue of the experimental station set up in Holland by the Philips organization (now handed over to and run by the Government) Mr. Philips confirmed the opinions of other prominent men who have visited this country recently, that (a) TV would have to come to these shores, on the score that it is impossible to stop the wheels of technological progress; and (b) that TV programmes need not be opressively costly if the most is made of indigenous material, and if those responsible for programmes had the necessary imagination and breadth of vision. An amusing personal observation on the impact of television concerned the difficulty of inducing the children to do their homework rather than look at the TV screen! It would seem that there is at least one country left where schoolchildren have still to do homework!

Mr. Philips had more than a little to say about the harmony existing on the industrial front in his country. The Philips organization has from the first been a leader in the field of industrial relations, and many are the stories that could be told illustrating the excellent co-operation that exists between management and staff. Suffice it to say that the only strike ever to stop work in the Philips factories took place during the German occupation of Holland, when Mr. Philips was imprisoned by the Germans for his part in organizing sabotage and go-slow tactics in his own factory, which was reluctantly doing enforced work for the invaders. The strike ended only when the Germans removed Mr. Philips to a hostages' prison, and threatened to shoot him if work was not resumed. He was subsequently set free, whereupon he continued his sabotage activities from "underground."

Much more could be said did space allow, and had time allowed Mr. Philips to have extended his press conference. He gave the impression that he was thoroughly enjoying himself, and that had not subsequent appointments intervened, he would have been pleased to continue ad lib. His press audience certainly would have!

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TRADE WINDS

(Continued)

Some American Radiotron valves are expected to be available by the end of this month and will include several types which have been scarce over recent years.

* * *

Our congratulations go to Peter Tucker, of National Electrical and Engineering Co., Ltd., who has taken unto himself a wife.

* * *

The National Electrical and Engineering Co., Ltd., announce that Mr. J. Sefton, after thirty years' service with them, retires this month. He is well known in the Hawke's Bay, Gisborne, and Wairoa areas, being manager of the Hastings branch. His successor is Mr. Allen Jones known to the radio and electrical field for his wide travels over the Manawatu and Wairarapa districts. He has also served as Wellington town traveller and recently on the executive staff in charge of contract and maintenance supplies. Mr. Angus Fergusson will take over the latter task. Our best wishes to Jack Sefton for a happy retirement, and to the others our congratulations on their promotions.

W. S. Green and Co., Ltd., announce their appointment as sole New Zealand agents for Walchris Co., of Denmark, manufacturers of radio and electrical equipment, including Walchris high-fidelity pick-ups.

* * *

Electro-Technical Industries, Ltd., advise their appointment as representatives of Messrs. Wingate and Co., Ltd., and of Messrs. C. R. People and Co., both well-known Auckland firms. These appointments cover the lower half of the North Island and Wellington Province respectively.

* * *

Mr. L. Arnold, of Messrs. Arnold and Wright, Ltd., has departed on a business trip to Canada, U.S.A., and the United Kingdom and Continent. He expects to be away until the beginning of March.

THE 1951 "R. & E." DIGEST OF CIRCUITS

A feast for the constructor. Contains a large selection of circuits which have appeared in "R. & E." over a period of approximately two years. Price 3s. 6d. Available from booksellers and radio stores or direct from Radio and Electronics.

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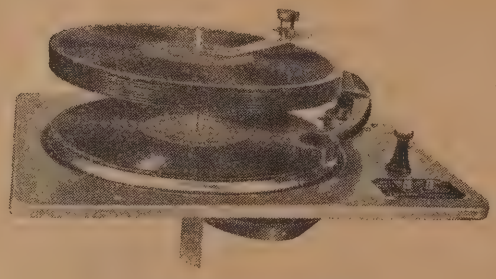

The Collaro RC500 Record Changer

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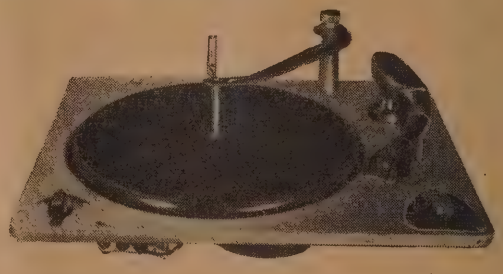

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Book Reviews

"GUIDE TO BROADCASTING STATIONS"

"Guide to Broadcasting Stations," sixth edition; published by "Wireless World" Dorset House, Stamford Street, London, S.E.1. Published on 28th August, 1951, at 2s. (postage 2d.). Size 5⅛ in. x 4½ in. (D16mo.) 94 pages.

Despite the efforts of international bodies and representations from individual governments the congestion in the long- and medium-wave broadcasting bands in Europe is eased but very little. There are at present nearly 200 stations working on unauthorized frequencies. Operating details of these stations and of the 350 or more authorized transmitters are included in the sixth edition of "Guide to Broadcasting Stations." This 94-page book also includes details of over 1400 short-wave broadcasting stations operating in 117 countries.

All the stations are listed both geographically and in order of frequency and the details have been checked against the frequency measurements made at the B.B.C. receiving station at Tatsfield.

The list giving operating details of nearly fifty V.H.F. broadcasting stations in Europe gives some indication of the growth of this form of broadcasting since the publication of the last edition which listed eleven. Details of fourteen European television transmitters are also included.

Contents include: Long- and medium-wave European Stations, with Frequencies, Wavelengths and Powers; Geographical List of Long- and Medium-wave European Stations, with Frequencies; Short-wave Stations of the World, with Frequencies, Wavelengths, Powers, and Call Signs; Geographical List of Short-wave Stations, with Frequencies; European Television Stations; Consol and Standard Frequency Stations; Metre-wave European Stations; British Amateur Transmitting Frequencies; International Allocation of Call Signs; Standard Time; Wavelength and Frequency Conversion, Formulae, and Tables.

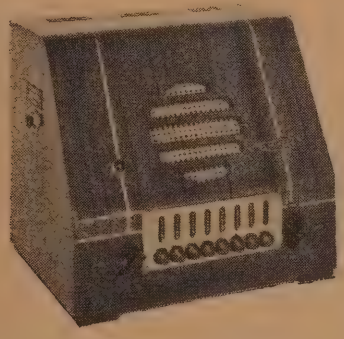
* * *

WIRELESS WORLD DIARY, 1952

"Wireless World" Diary 1952. Published October, 1951, by Iliffe and Sons, Ltd. Size 4½ in. x 3⅛ in. wide. Eighty pages of reference material—plus the usual diary pages of a week to an opening. Morocco leather 6s. 1½d. Rexine 4s. 3½d. (English prices.)

Diversity of information is one of the outstanding features of the "Wireless World" Diary, now in its 34th year of publication. In addition to general information and addresses of radio organization both in the United Kingdom and abroad, the 80-page reference section includes base connections for some 670 valves, design data and the kind of technical information so often needed but seldom readily available in tabloid form.

Compiled by the staff of "Wireless World", the technical data includes formulae ranging from Ohm's Law to



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P.A. power requirements; abacs for the graphical estimation of data such as coil windings and circuit constants; circuit diagrams varying from simple detector circuits to a 90 mc/sec. converter; and details of television and F.M. aerials.

Contents include: Abacs. Addresses of Radio Organizations. Aerials, S.W., Television, and F.M. Air-Cored A.F. Chokes. B.A. Screws, Nuts and Drill Sizes. Circuit Diagrams. Codes. "Q" and Morse. Conversion Table. Graphical Design Data. Greek Alphabet. Insulants and Dielectrics. Electrical Interference. International Prefixes. International Organizations. Licence Regulations. Mathematical Signs. Resistance of Metals. Modulated Test Oscillator. 90 Mc/sec. Converter. Resistor and Capacitor Marking. Resistors in Parallel. Standard Time. Graphical Wireless Symbols. Units and Definitions. Valve Base Connections. Wattage Table. Waveband Classification. Wire Tables.

RIDER TO PUBLISH TV-ELECTRONICS VOCATIONAL GUIDE

John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N.Y., announces a forthcoming publication "TV and Electronics as a Career."

Roughly speaking, the electronics industry is composed of seven branches of activity: engineering, broadcasting, manufacturing, servicing, parts and receiver distributing, sales representation, and retailing. Each of these special fields is discussed in the text by an acknowledged authority currently active in the field.

The men who have collaborated to make this book a valuable guide to the individual seeking employment in the electronics industry are J. R. Poppele, vice-president W.O.R.-TV, R. V. Peterson, assistant manager, Electronics Division, Admiral Corporation; W. H. Bolke, manager, custom service operation section, R.C.A. Service Corporation; Ira Kamen, director of TV development, Brach Manufacturing Corporation; and R. H. Dorf, television consultant.

The book is unique in as much as it is the only definitive text that gives all the whys and wherefores of the electronics industry for the newcomer embarking on a career, or the electronics "oldtimer" desiring to switch to another field of specialization within the industry.

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A Practical Way of Building Speaker Dividing Networks

PART II (Conclusion)

The last instalment of this article ended with the query whether an ordinary R.K. choke would not do for the dividing networks.

It most certainly would not do, for such a choke, though it might have the correct inductance, would have a resistance almost as high as that of the impedance of the speaker. If it were to be used, it would soak up all the available audio power, leaving very little for the speakers, and finally disappear, like djinn, in a cloud of smoke! A useful choke for the purpose, then, must have a very low D.C. resistance, preferably of the order of a fraction of an ohm. This can be realized by winding a large air-cored coil from heavy wire—not thinner than, say, 24 gauge, but the difficulty here is that of determining its inductance. Those who have the requisite measuring equipment would be able to manage quite well, but even so, such a choke has its disadvantages. It would be rather bulky, for example, and would be difficult to mount satisfactorily. Especially is this true where the circuit is used that requires two such chokes, for they must be mounted so that there is no coupling between them if the filter is to work properly. Ordinary iron core materials cannot be used, for although only a few turns would be needed to give the correct inductance, the measuring difficulty still occurs, and, in addition, the Q of such a coil would almost certainly be too low for it to be of any use, owing to the losses in the iron core material.

It can be seen, therefore, that the choke problem is quite a vexed one. However, the new material known as "Ferroxcube" comes very nicely to the rescue in the following ways. It is a high-permeability material of low electrical conductivity that does not need laminating in order to give it very low eddy-current losses. Because of this it can be moulded into any desired shape of core, and one of the most useful forms is the "pot" type illustrated in this article. This kind of core has the very great advantage that the magnetic field is totally enclosed, so that several coils wound on them can be placed in as close proximity as may be desired with negligible chance of undesired couplings existing between them. From our point of view, however, another very great advantage appears. Because of the fact that the coil is totally enclosed by the core material so that no leakage field exists, the inductance of any coil wound on the plastic former provided with the core can be accurately specified as to inductance simply by a knowledge of the number of turns. The cores are made with pre-determined and known gaps existing between the halves of the central cylinder, and at the moment, those available here have a gap of 0.3 millimetres, and the published figures on these show that 1125 turns are required in order to get an inductance of 1 henry. Now, remembering that the inductance of a

coil is proportional to the square of the number of turns, it is a simple matter to work out just how many turns are needed to achieve a given inductance. For example, one coil required for our experimental work on dividing networks needed to have an inductance of 2.4 millihenries. Accordingly, the number of turns needed was found from:—

$$N = 1125x\sqrt{\frac{2.4}{1000}} = 58 \text{ turns.}$$

The general formula for inductances in millihenries is:—

$$N = 112.5\sqrt{\frac{x}{10}}$$

where x is the required inductance in millihenries, and N is the number of turns. This formula has been found to be remarkably accurate. Quite accurate enough, indeed, to enable coils for dividing networks to be made up and used without measurement. From the point of view of the amateur, and the professional man who is not blessed with extensive measuring equipment, this is a great step forward, for not only can inductances be arrived at in this simple way, but their Q is remarkably high, so that one can be assured of excellent performance from the filter, once built. It is true that in order to complete the job one still needs to be able to measure capacity with reasonable accuracy, or, failing this, to have an audio oscillator that is accurately calibrated as to frequency. However, most people these days have one or other of these facilities, or at least can borrow or beg the use of them for a short time. Dividing networks, in short, come within the scope of the amateur not only to design, but also to build.

NETWORK CALCULATIONS

Fig. 4 gives the circuits and calculations for the three types of network illustrated in Fig. 3. These formulae are self-explanatory, and should need no further comment.

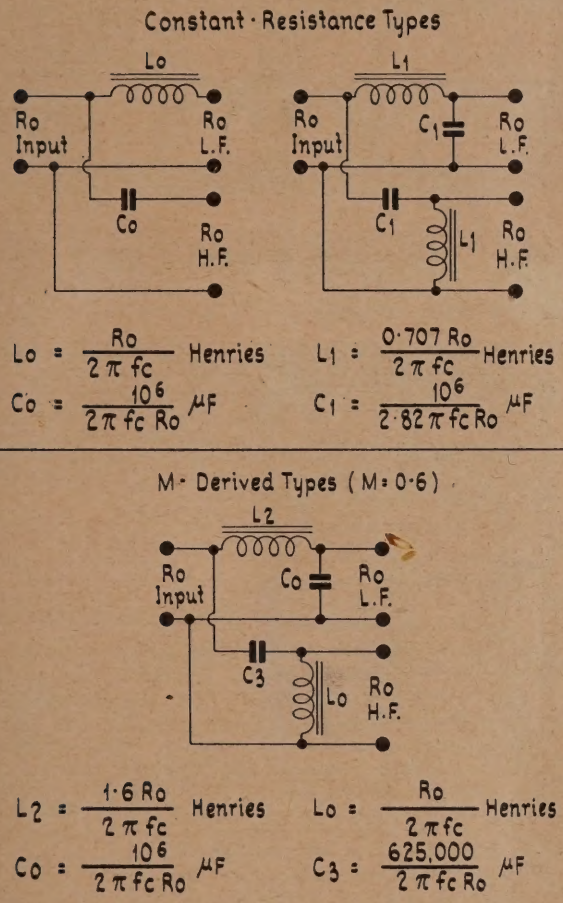

Fig. 4

Radio Trader Retires

(Continued from Page 39.)

Mr. E. J. Isaacs, a director of the company, from Auckland, was master of ceremonies, and presented to the guest of honour a toy bagpipes in the hope that it would serve to keep the memory of old Scottish associations.

The ceremony closed with the singing of the National Anthem.

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Philips Experimenter

(Continued from Page 25.)

TANK CIRCUIT AND R.F. PHASING COIL

The coil in the plate circuit of the balanced modulators is mounted underneath the chassis, since it is series fed and is thus at H.T. potential. It is wound on a bakelized paper former 1½ in. in diameter, with 38 turns on 24-gauge tinned copper wire, double-spaced. It is tapped at the centre for connection to the R.F. choke L_3.

The phasing coil, L_4, is wound on a slug-tuned former, taken from a ZC1 B.F.O. coil. This is very convenient and cheap to use, since it has provision for single-hole mounting to the chassis, and has an adjustment screw for moving the slug, thus trimming the coil to just the right inductance. The adjusting screw comes out above the chassis. The winding consists of 31 turns of 30-gauge enamelled copper wire, close-wound. The original windings are removed before winding this coil, and the original lugs are used to terminate the new winding.

The next instalment of this article will describe the setting up of the unit in detail.

(To be continued.)

Proceedings of N.Z.E.I.

(Continued from Page 22.)

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Christchurch

On Monday, 29th October, 1951, a meeting was held which took the form of a visit to the P and T. Department's carrier room. There was an attendance of twenty-two members and visitors.

Mr. L. J. Fussell conducted the party around the carrier room and explained the equipment in detail. Members showed great interest in the equipment and at 10 p.m. Mr. Withers proposed a vote of thanks, which was carried by acclamation. The members were reluctant to leave and were then shown the teleprinter room, and the meeting finally closed at about 10.30 p.m.

Tube Data

(Continued from Page 31.)

plate voltage of 1000 volts, a fixed bias of at least —7.5 volts should be used.

The 826 can be operated at maximum ratings at frequencies as high as 250 megacycles. It may be operated at higher frequences provided the maximum values of plate voltage and plate input are reduced as the frequency is raised (other maximum ratings are the same as shown under Characteristics). The table below shows the highest percentage of maximum plate voltage and power input that can be used up to 300 megacycles. Special attention should be given to adequate shielding of the 826 at these frequencies.

Maximum permissible percentage of maximum rated plate voltage and plate input

	Frequency Megacycles	
	250	300
Class B R.F. telephony	100%	90%
Class C grid-modulated telephony	100%	90%
Class C plate-modulated telephony	100%	80%
Class C telegraphy	100%	80%

When the 826 is operated at the ultra-high frequencies, push-pull operation is recommended. This connection has the advantage of simplifying the balancing of high-frequency circuits by providing symmetry of circuit lay-out. In oscillator service, it is desirable to connect the two grid terminals and the two plate terminals of each tube in parallel in order to reduce the respective lead inductance.

Pick-up Pre-amp.

(Continued from Page 10.)

the 1 or 10 times position, and the switch S_2 closed, to cut out the bass boost, all will be in order.

One can readily imagine this little circuit being made up by an enterprising parts dealer, together with built-in compensating networks for different types of crystal pick-ups, so that a switch will select the network for the particular crystal pick-up, while the pre-amp. itself will cope with any sort of magnetic unit. The whole could then be used as a permanent part of a reproducing system used in the shop to demonstrate different pick-ups, amplifiers, speakers, etc. And, as we said before, it should be worth its weight in gold to the experimenter who likes to play with different pick-ups and compensating networks.

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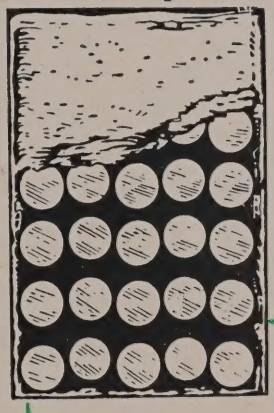

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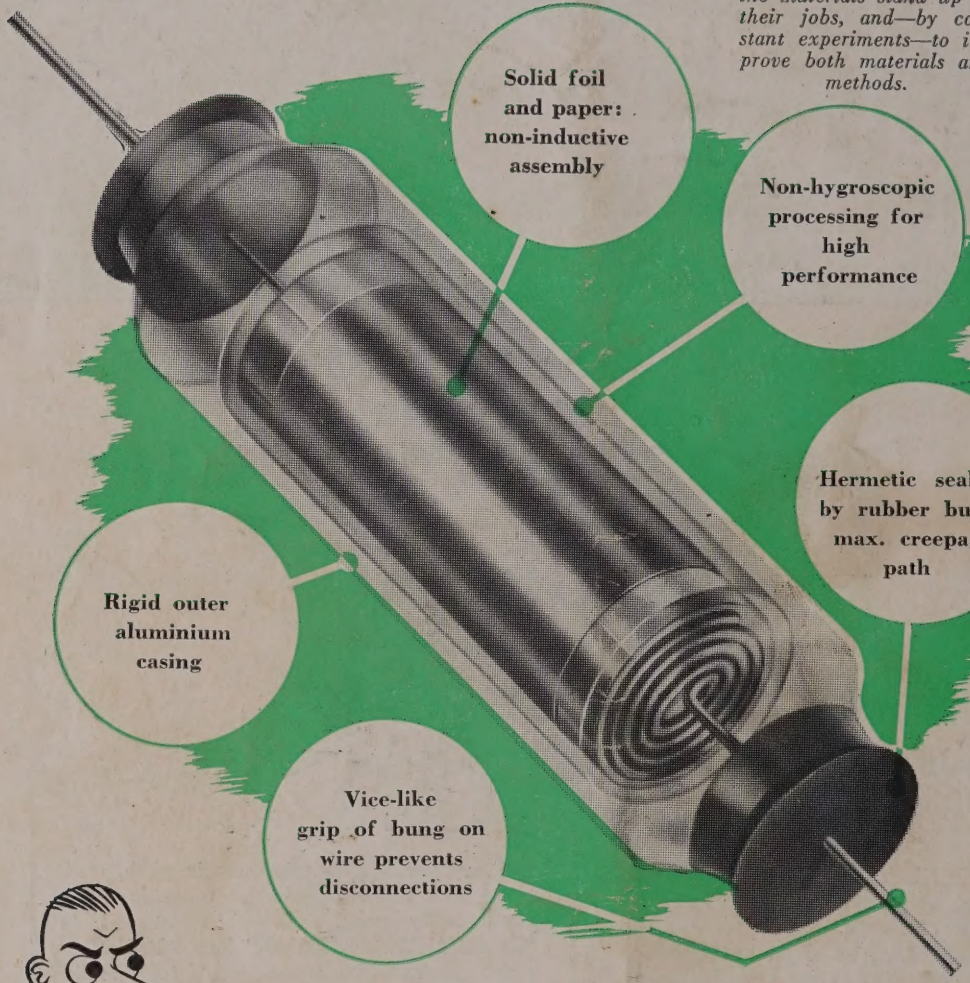
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